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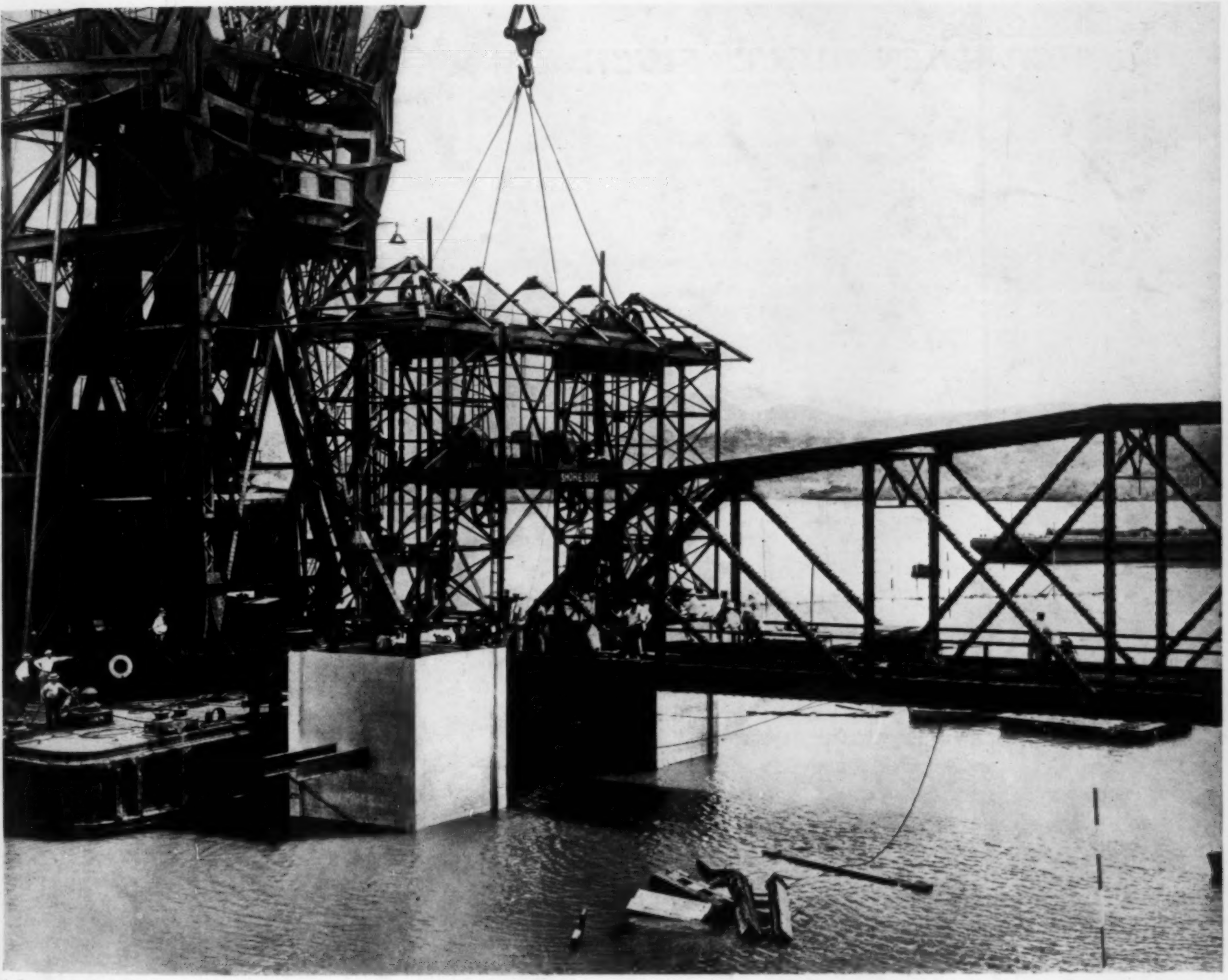

Thatcher Highway Crossing of Panama Canal
Placing Lifting Frame for Ferry Ramp

Volume 3 AMERICAN SOCIETY OF CIVIL ENGINEERS FOUNDED 1852 *Number 2*

FEBRUARY 1933

"The dead take to their graves, in their clutched fingers, *only that which they have given away*"

THIS is your chance *to do more good* with the money you give to others than was perhaps ever before possible in the history of this country.

First, because the *need* is greater than ever before. Second, because more of every dollar you give will go to provide your fellow human beings with food, shelter, medical help—the bare necessities of living.

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Read again the great words attributed to Rousseau which are printed at the top of this page. Then *give* through your established welfare and relief organization, through your community chest, or through your local emergency relief committee.

NEWTON D. BAKER, CHAIRMAN
NATIONAL CITIZENS' COMMITTEE

WELFARE AND RELIEF MOBILIZATION, 1933

Among Our Writers

Edward M. Browder, Jr., received one of the three Junior Membership awards of the Los Angeles Section for his senior thesis at the California Institute of Technology in 1927. Following graduation he had three years of varied engineering experience in California. Since 1930 he has been with The Panama Canal, designing miscellaneous timber, reinforced concrete, and steel structures.

John H. Gregory has had wide experience as a consulting engineer and has been connected with many of the leading water supply and sewerage works in the United States. In August 1932, he was appointed one of the members of the Engineers' Advisory Board of the Reconstruction Finance Corporation.

Robert A. Allton has held the following positions: Assistant Engineer, New York State Department of Health; Assistant Engineer and Principal Assistant Engineer with Pearse and Greeley, Hydraulic and Sanitary Engineers; Designing Engineer on a 33-mgd sewage treatment works for Akron, Ohio; and, since 1928, Sewage Disposal Engineer with the City of Columbus, Ohio.

James H. Blodgett had his first practical experience as Assistant Engineer with the Town of Lexington, Mass., from 1920 to 1922. After nearly a year's connection with Metcalf and Eddy of Boston, he went to Akron, Ohio, as Assistant Engineer on the design and construction of its new sewage disposal plant. In 1928 he was engaged by the Division of Engineering and Construction of the City of Columbus, Ohio, as Designing Engineer, and since 1930 has been Field Engineer on sewage disposal work in that city.

Millard A. Butler has had a wide experience in railroad engineering. For 17 years he was with the Great Northern Railway. In 1928 he was sent to Persia by Ulen and Company, where he had charge of railroad location on 250 miles of standard-gage railroad and directed the port and harbor development constructed by his company for the Persian Government. Mr. Butler now conducts an engineering practice in Norfolk, Va.

H. H. Chapman, after five years as Superintendent of the State Agricultural Experiment Station in Grand Rapids, Minn., received his M.F. degree at the Yale Forest School in 1904. From 1905 to 1911 he served successively as instructor and assistant professor in the Yale Forest School, and in 1911 was made Harriman Professor of Forest Management there. He is the author of several books on forestry.

Herbert S. Swan has engaged in city planning and zoning work since 1911 and has acted as consultant to many municipalities. He has been a member of the committee on city planning and zoning of President Hoover's Conference on Home Building and Ownership. Mr. Swan is the author of numerous reports and articles on city planning and zoning.

C. H. Buckius has been with the Pennsylvania Department of Highways since September 1907. He started as chainman in the engineering corps and advanced through successive steps to his present position, that of District Engineer for District 5. Because of his background of wide experience in state highway work he is considered an expert in this field.

Herbert H. Wheaton graduated in 1922 from the University of Wisconsin. He then went to California where for the following nine or ten years he taught engineering at the Fresno State College and directed the summer surveying camp. During this period he found time to continue his professional studies at the University of California, where in 1929 he received an advanced degree in Civil Engineering. Professor Wheaton is now in Europe as a Freeman Traveling Scholar of the Society.

Volume 3 Number 2

February 1933

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CIVIL
ENGINEERING
February 1933

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Number 2

Panama Canal Crossed by Ferry

Government Completes Thatcher Highway Across the Canal Zone and a Free Ferry Over the Canal

By Edward M. Browder, Jr.
Junior, American Society of Civil Engineers
Structural Draftsman, The Panama Canal, C.Z.

A FERRY across the Panama Canal and a connecting highway on the western side of the Canal Zone, to reunite the two parts of the Republic of Panama, have recently been completed and named in honor of Representative M. H. Thatcher, of Kentucky, who was instrumental in securing legislation for the highway. He was formerly a member of the Isthmian Canal Commission and head of the Department of Civil Affairs on the Canal Zone. A tidal variation of 22.6 ft necessitated the ferry approach structure described here. Hoisting the assembled ramps and gallows frames into place by means of 250-ton floating cranes was a feature of the construction.

BY connecting the two oceans, the Panama Canal not only divided the two continents, making impossible all overland transportation between North and South America, but also isolated sections of the Republic of Panama. Thus a highway for ocean transportation became a barrier to overland transportation. This barrier, one of the several obstacles to the proposed Pan-American Highway, was eliminated in September 1932 by completion of the Thatcher Ferry and Highway, representing a part of the contribution of the United States of America toward international communication. The project also fulfills the obligation of the United States to the Republic of Panama by providing a permanent connection for the two parts of that country.

The western half of the Republic of Panama is rich in agricultural products, especially cattle and coffee. Until recently, these products were brought to Panama City in small coastal boats, often at considerable expense, loss of time, and material damage to the products. Improvement of roads in the Republic of Panama was begun in 1923. Since that time, traffic of steadily increasing magnitude between Panama City, the Canal Zone, and the western part of the Republic of Panama has been using the route shown on the accompanying map, Fig. 1. The connection at the Canal was provided by a toll-free ferry service consisting of an improvised tug and barge at Pedro Miguel.

As early as 1924, studies were made by The Panama Canal to determine the most feasible method of effecting a more permanent crossing at the Canal. Objection was found to a tunnel on the ground of excessive cost, and a bridge was considered impractical, as well as dangerous from the point of view of defense. A ferry system, with approaches at each side of the Canal, was deemed most economical.

In view of the improvement and grading of 250 miles of roads in the western part of the Republic of Panama, completed in 1930, and the resulting increase in both passenger and commercial traffic, the United States recognized its obligation to connect the route with a modern highway and canal crossing at Balboa. In May, 1930, Congress appropriated $1,000,000 for the construction of a toll-free highway and ferry to reunite the Republic of Panama.

THATCHER HIGHWAY CONNECTION

Surveys were begun at once by the Municipal Engineering Division of The Panama Canal, and an excellent alignment for the new highway was secured from Balboa to the Canal Zone boundary near Arraijan, where a connection was made with the Panama National Highway, as shown in Fig. 1. Construction work on this section, called the Thatcher Highway, was completed in April 1932. It is 6.8 miles long and is surfaced with a 7-in. concrete slab 18 ft wide, thickened to 9 in. at the edges. The slab is reinforced longitudinally by 18 bars $^{3}/_{8}$ in. in diameter, and transversely by $^{1}/_{4}$-in. bars, spaced 2 ft on centers. The transverse construction joints are spaced 48.5 ft on centers, and there is a longitudinal asphalt filler $2^{1}/_{2}$ in. deep on the center line. With the exception of one curve adjacent to the ferry landing, which has a radius of 200 ft, the minimum radius of curvature is 360 ft. The maximum grade used is 7 per cent uncompensated.

From the following summary it is obvious that the new route from Balboa to La Chorrera has many advantages over the superseded route:

	Old Route	New Route
Distance from Balboa Post Office to La Chorrera, in miles	30.3	19.3
Highest elevation, in feet	521.5	437.0
Minimum radius of curvature, in feet	25 ±	100.0
Maximum grade	12 ± per cent	7 per cent (except on ramp)

FERRY BOATS DRIVEN BY DIESEL POWER

The Mechanical Division of the Panama Canal designed and built the two diesel ferry boats, named *President Roosevelt* and *Presidente Amador*, the latter in honor of the first president of the Republic of Panama. The boats are 125 ft long by 38 ft wide, and have a loaded draft of 7 ft 4 in. and a capacity of 35 passenger automobiles. Power for each boat is supplied by an 8-cylinder, straight diesel-type unit, with a $12^{1}/_{2}$ by 16-in.

cylinder, developing 350 bhp (brake horsepower) at 265 rpm. Propellers 58 in. in diameter, with a 58-in. pitch, one at each end of the boat, always operating simultaneously, will give a speed of 9.25 knots per hr.

To the Office Engineer of The Panama Canal was assigned the problem of the approach structure. The tidal variation of the Pacific Ocean at Balboa is 22.6 ft. This variation, together with the assumed maximum grade of 12 per cent, determined the length of the approach structure. A scheme involving a ramp, pivoted on an abutment at the land end and resting on a pontoon at the water end, was abandoned because of the difficulty of anchoring the pontoon in the rough water that is occasionally encountered at the site chosen. A more stable, determinate scheme was investigated and adopted. This involved a ramp pivoted on an abutment at the land end, the outer end being suspended from a gallows frame founded on bedrock. The details of the adopted design are shown in Fig. 2.

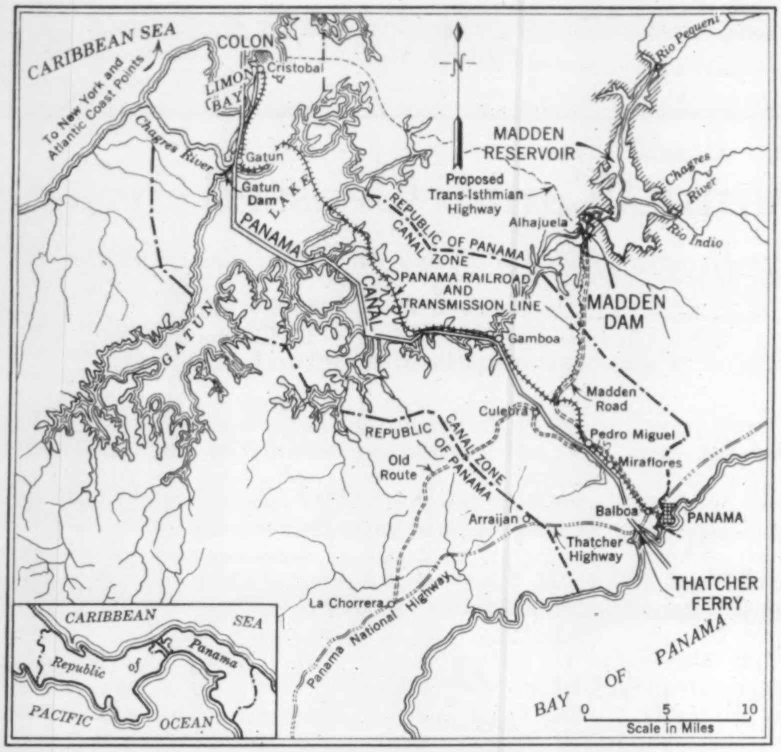
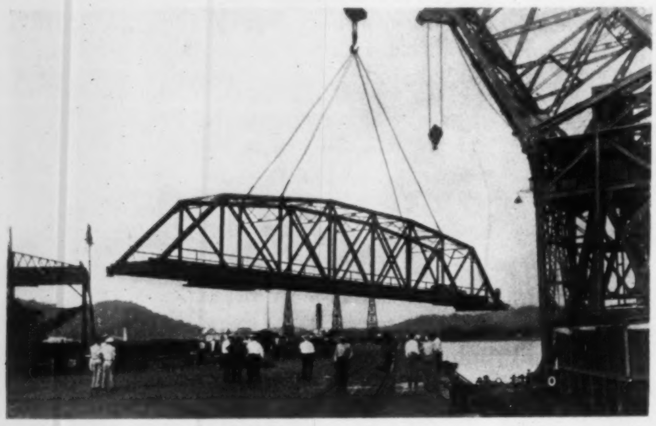

CARIBBEAN SEA
To New York and Atlantic Coast Points
COLON
Cristobal
LIMON BAY
Chagres River
Gatun
Gatun Dam
GATUN LAKE
PANAMA CANAL
MADDEN RESERVOIR
Proposed Trans-Isthmian Highway
Alhajuela
Rio Pequeni
Chagres River
Rio Indio
REPUBLIC OF PANAMA
CANAL ZONE
PANAMA RAILROAD AND TRANSMISSION LINE
MADDEN DAM
Gamboa
Madden Road
Culebra
Pedro Miguel
Miraflores
REPUBLIC OF PANAMA
CANAL ZONE
Old Route
Arraijan
Balboa
PANAMA
Thatcher Highway
THATCHER FERRY
La Chorrera
Panama National Highway
BAY OF PANAMA
0 5 10
Scale in Miles
CARIBBEAN SEA
Republic of Panama
PACIFIC OCEAN

FIG. 1. THATCHER HIGHWAY AND FERRY CROSSING AT BALBOA

The ramp, a steel truss bridge, was designed under specifications adopted by the U.S. Department of Agriculture, Bureau of Public Roads, in 1924. The H-20 truck loading assumed, will accommodate the heaviest trucks on the Isthmus of Panama as well as the medium-sized tanks of the U.S. Army. Considering the fact that the required time for loading and unloading the ferry boat will be short, it was deemed sufficient to provide only one lane for traffic on the ramp. The ramp is composed of two 8-panel, non-parallel chord Pratt trusses, placed 14 ft 6 in. from center to center, with steel floor beams, stringers, and riveted connections throughout. Timber flooring was found economical because of the saving in dead weight.

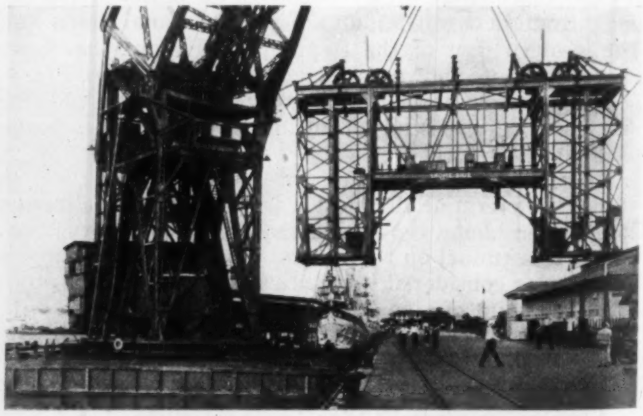
Because of the heterogeneous character of the traffic, which varies from a native *caballo* loaded with a stem or two of bananas, to the latest type of six-wheeled, pneumatically tired truck and trailer, it was desired that the ramp should have the minimum practical grade that could be obtained at the site. A length of 176 ft was chosen for the ramp, so as to give an absolute maximum grade of 12 per cent when the land end of the ramp is in position on the abutment above extreme high water and the outer end is lowered to receive the ferry boat at extreme low water. Even with 24-hr operation, the maximum grade of 12 per cent is required only once in four years. At average low water, the grade on the ramp is 9.1 per cent, and at mean sea level, 5.4 per cent.

The ramp has no unusual features except at the outer end, where a 16-ft apron is provided to permit variations in the loaded and unloaded draft of the ferry boat, and also to allow for variations in water level while the boat is receiving or discharging traffic. At the two landing sites in Inner Balboa Harbor, a 2-ft wave action is possible, and at mean tide the water level may change as much as a foot in 15 min. One end of the apron is attached through springs to a floor beam at a sub-panel point, 10 ft from the end pin of the truss. Slight movement of the apron, either longitudinal or transverse, is permitted by these



TRANSFERRING RAMP TO BARGE

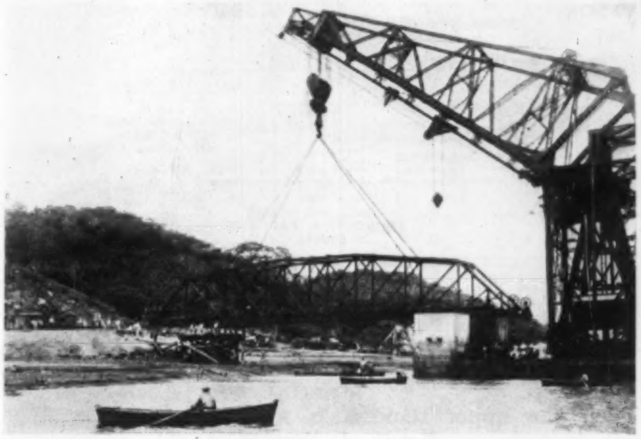
176-Ft East Tidal Ramp Span, Fabricated on a Dock at Balboa, Was Transferred to a Barge by the 250-Ton Floating Crane, *U.S. Ajax*, on July 18, 1932



TRANSFERRING GALLOWS FRAME TO BARGE

Part of Counterweight and Hoisting Equipment Attached to Frame Before Removal from Dock for Transfer to Ferry Site. These Frames Raise and Lower End of Ramp with the Tide springs. A bumper 4 ft 6 in. high, of Almendra hardwood between steel plates, curved in plan to conform to the end of the ferry boat, is rigidly attached to the steel stringers of the apron. After the ferry boat is tied to the ramp, the ramp is lowered until the outer end of the apron rests on the ferry boat. When the ramp is not in use, the apron rests on the end girder of the ramp.

A side bumper plate is placed at the end pin of the truss to prevent the apron from colliding with the truss. A ferry-boat impact load of 30,000 lb, acting transversely against this plate, was assumed. In the design of the ramp, a ferry-boat impact load of 30,000 lb per bridge stringer, acting longitudinally, was assumed to be applied through the apron. Further, it was assumed that this impact is carried through the stringers to the bottom laterals, then to the lower chord members, and finally to the shore abutments through the end castings.



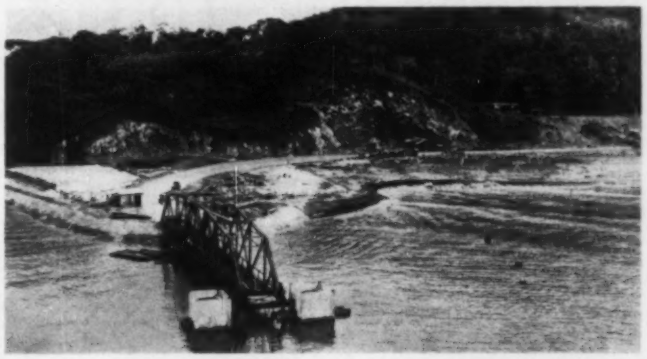
Floating Crane "U.S. Hercules" Lowering the West Ferry Ramp, Which Weighed 125 Tons, on to the Temporary Cribbing from Which It Was Later Rolled Into Position

RAMP AND APRON COUNTERWEIGHTED

Both the ramp and the apron are counterweighted in the gallows frame, to reduce operating costs. The ramp counterweights are of concrete, poured around a structural steel frame, and are connected to the ramp at the end floor girder by a 2-in. stud-link chain made of wrought iron, which passes over two sheaves in the top of the gallows frame. Guide rollers are attached to the steel counterweight frames. As an auxiliary to the mechanical load brake attached to the hoisting equipment, a locking device is provided on each counterweight, operated by an electric solenoid, to prevent movement of the ramp when the live load is on it. This locking device also prevents movement of the ramp in case of any accident to the hoisting cables or equipment. A plunger or dog on the locking device, which meshes with a continuous row of teeth on the counterweight guide, is held in contact by a spring. When power is applied to raise or lower the ramp, the solenoid is energized and simultaneously compresses the spring, disengaging the dog. When the power is cut off, the spring resumes its position and the dog engages. The continuous row of teeth on the counterweight guide is securely fastened to the gallows frame and its foundation.

Each of the two apron counterweights consists of 9 cast-iron blocks 4 ft by 1 ft by 6 in., threaded on to a bolt $1^{1}/_{4}$ in. in diameter, attached to the end of the apron by a steel cable $^{3}/_{4}$ in. in diameter, which passes over a single sheave 45 in. in diameter, in the top of the gallows frame. These counterweights are also guided by angles attached to the gallows frame, and act independently of the ramp counterweights.

The ramp is hoisted by means of a 25-hp slip-ring electric motor of the hoist type, geared to two drums 4 ft in diameter, on which are wound steel cables 1 in. in diameter. The cables are connected to the end pins of the truss through a sheave system. The electric motor, the mechanical load brake, the two drums, and the three electric transformers are located in the machinery room of the gallows frame, immediately above the end of the ramp. Although the machinery room is easily accessible by means of a ladder, the movement of the ramp is controlled by an operator who stands on a small platform near the end of the ramp, outside the roadway. On this platform there is a drum controller for the electric motor.



Thatcher Ferry Tidal Ramp Over the Panama Canal at Balboa

West Ramp Span in Place on Cribbing. Gallows-Frame Lifting Gear, Pile Rack Fenders, and Apron Not Yet in Place

To prevent the ramp from making any horizontal movement, it is guided by means of rollers on each end of the end floor girder. These rollers make contact with guides of creosoted timbers 12 by 12 in., faced with steel plates, all securely fastened to the gallows frame foundation with countersunk bolts.

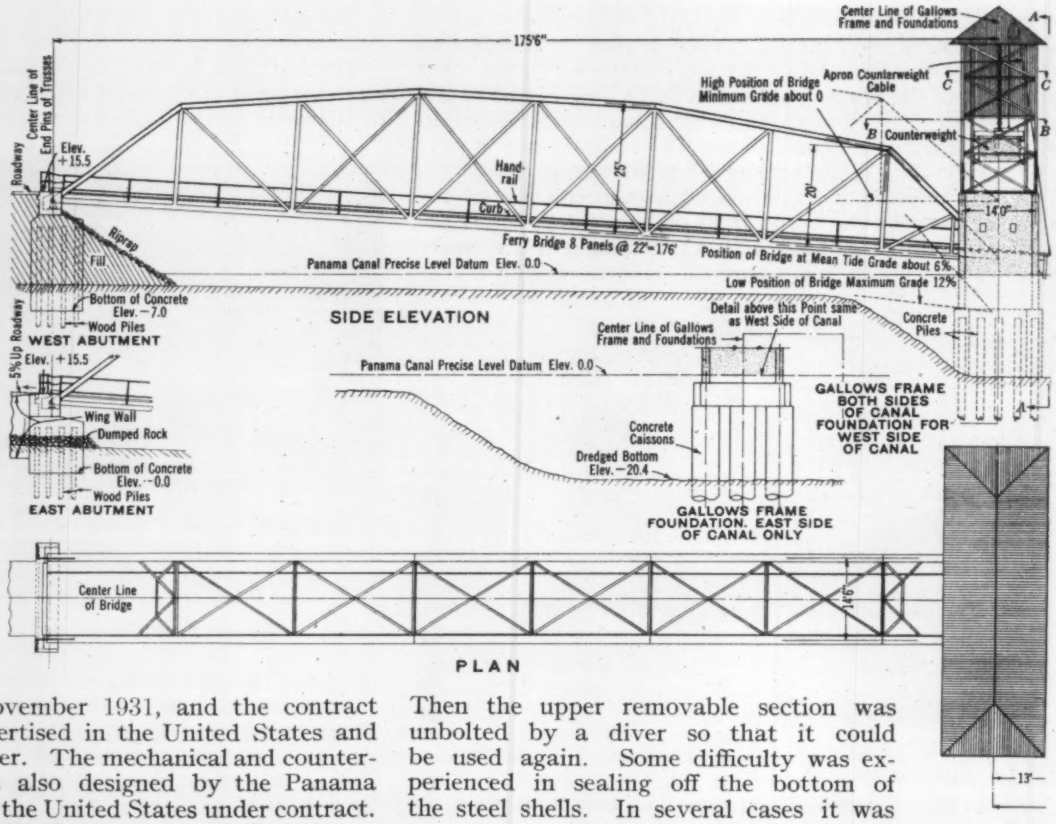
GALLOWS FRAMES FOUNDED ON ROCK

The gallows frame is the steel structure that supports the water end of the ramp. The machinery room, which is in the top of the gallows frame, has a reinforced concrete floor and is enclosed by galvanized iron siding. On each side of the machinery room, space is allowed for the travel of both the apron and ramp counterweights. A corrugated iron roof covers the structure.

The foundations of the gallows frame are carried to bedrock. At the east ferry landing, rock was at such elevation (−35 ft below mean sea level) that concrete caissons were found economical. Six steel cylindrical shells, each 4 ft 9 in. in diameter, were used. These were sunk to rock, pumped dry, and filled with concrete.

At elevation −6.0, at the top of the caissons, reinforced concrete beams distribute the loads imposed by the gallows frame to the caissons. Above these beams, a reinforced concrete wall and column section is continued to elevation +17.5, at which elevation the steel framework of the gallows frame is bolted to the concrete substructure.

Since rock is much lower at the west ferry landing (−50 ft below mean sea level), a different method was followed there. Precast reinforced concrete piles were driven, cut off at elevation −8.0, and secured against movement by a reinforced pile capping extending from −6.0 down to −20.0. Above elevation −6.0, the reinforced concrete wall and column section is similar to


Center Line of Gallows Frame and Foundations
A
175'6"
Center Line of End Pins of Trusses
Roadway
Elev. +15.5
High Position of Bridge Minimum Grade about 0
Apron Counterweight Cable
C
C
B Counterweight
B
Hand-rail
25'
20'
14'0"
Curb
Riprap
Fill
Ferry Bridge 8 Panels @ 22'=176'
Position of Bridge at Mean Tide Grade about 6%
Panama Canal Precise Level Datum Elev. 0.0
Low Position of Bridge Maximum Grade 12%
Bottom of Concrete Elev. -7.0
Wood Piles
WEST ABUTMENT
SIDE ELEVATION
Detail above this Point same as West Side of Canal
Center Line of Gallows Frame and Foundations
Concrete Piles
5% Up Roadway
Elev. +15.5
Panama Canal Precise Level Datum Elev. 0.0
GALLOWS FRAME BOTH SIDES OF CANAL FOUNDATION FOR WEST SIDE OF CANAL
A
Wing Wall
Dumped Rock
Concrete Caissons
Dredged Bottom Elev. -20.4
Bottom of Concrete Elev. -0.0
Wood Piles
EAST ABUTMENT
GALLOWS FRAME FOUNDATION, EAST SIDE OF CANAL ONLY
Center Line of Bridge
14'6"
PLAN
13'

that at the east ferry landing. No unusual features were incorporated in the design of either foundation. The abutments at the land end of the ramps, about which the ramps pivot, are of reinforced concrete on wood piles, driven to rock. A concrete pile capping extends down to mean sea level to protect the piles and increase their stability.

Construction was carried forward by The Panama Canal, beginning in October 1931 with the driving of piles for the abutments at the land end of the ramps. The designs for the structural steel gallows frames and ramps were completed in November 1931, and the contract for fabrication was advertised in the United States and awarded to the low bidder. The mechanical and counterweight equipment was also designed by the Panama Canal and fabricated in the United States under contract.

Reinforced concrete piles for use on the gallows frame foundation on the west side were cast, loaded on barges, floated to the site, and driven with no unusual difficulties by means of a floating pile driver. The complete form for the pile capping and for the wall and column section up to elevation 0.0 was made on the dock at Balboa, hoisted and towed to the site by means of the huge 250-ton floating crane of The Panama Canal, *U.S. Ajax*, and lowered over the piles. The bottom of the form was then sealed off with 2 ft of concrete poured under water; the form was pumped dry; and concrete for the pile capping and wall section was poured in the dry. The forms were carried on up to elevation +17.5, the top of the foundation, and concrete was poured at low tide.

On the east side, where concrete caissons were used for the foundation of the gallows frame, sectional steel cylinders were fabricated in the shops of the Mechanical Division of The Panama Canal in Balboa, carried by barge to the site, lowered to position, and forced down to bedrock by the addition of weights. The top mud and silt inside the caissons were excavated by pumping, and the more solid material and the top of the rock ledge were removed by hand and raised to the surface in buckets, while the caisson was kept pumped out. The steel shells were held in an upright position by means of four piles and a timber frame or yoke at the top. The steel forms used were of two types, permanent and removable. The permanent-type shells were cylindrical, 4 ft 9 in. in diameter, $^3/_8$ in. thick, and of varying lengths from 18 to 30 ft, with a connection angle provided for the attachment of the next section. The removable type was made up of two semi-cylindrical shells, $^3/_8$ in. thick and 30 ft long, bolted together longitudinally and also to the adjacent sections at each end. A permanent section was used at the bottom of each caisson, and a removable section was used above. When the excavation had been carried 1 ft or more into the rock, if seepage was small, the concrete was poured in the dry and cured. Then the upper removable section was unbolted by a diver so that it could be used again. Some difficulty was experienced in sealing off the bottom of the steel shells. In several cases it was necessary to ram clay around the edge and bottom of the caisson.

To save time, the reinforced concrete beams that distribute the load of the gallows frame to the concrete caissons were poured on the dock at Balboa while the caissons were being completed. Also, the wall and column section above the beams, up to elevation 0.0, was cast with the beams. The entire section was hoisted, towed to the site, lowered into position over the caissons, and secured with dowel pins. Forms were carried on up to elevation +17.5, as on the west-side gallows-frame foundation, as previously described.

RAMP TRUSSES SET BY FLOATING CRANES

The structural steel for the two ramps and two gallows frames was received from the United States, and was assembled and erected on a dock at Balboa, near the shops of the Mechanical Division. Erection conditions were ideal. With the completion of the foundations in July 1932, the ramps and gallows frames were lifted off the dock, loaded on a barge, towed to the site, and set in place by the 250-ton floating cranes of the Panama Canal, *U.S. Hercules* and *U.S. Ajax*, shown in the photographs. The *U.S. Hercules* was used to place the west ramp and the *U.S. Ajax* to place the east ramp. In the design of the ramps, this method of erection was anticipated, and pins were located in the top chords of the trusses at panel points U2 and U5. The top cover plate of the top chord members was left open at these points. A 6 by 6-in. timber was wedged in between the trusses at each of these two points to prevent distortion or damage to the sway frames, and a steel cable 2 in. in diameter was secured at each of the four pin connections.

The substructures of the gallows frames were designed and built to accommodate two 20-in., 81.4-lb I-beams on each side of the ramp, projecting from the foundations toward the center of the structure. These beams were used to facilitate erection, but they will also provide a

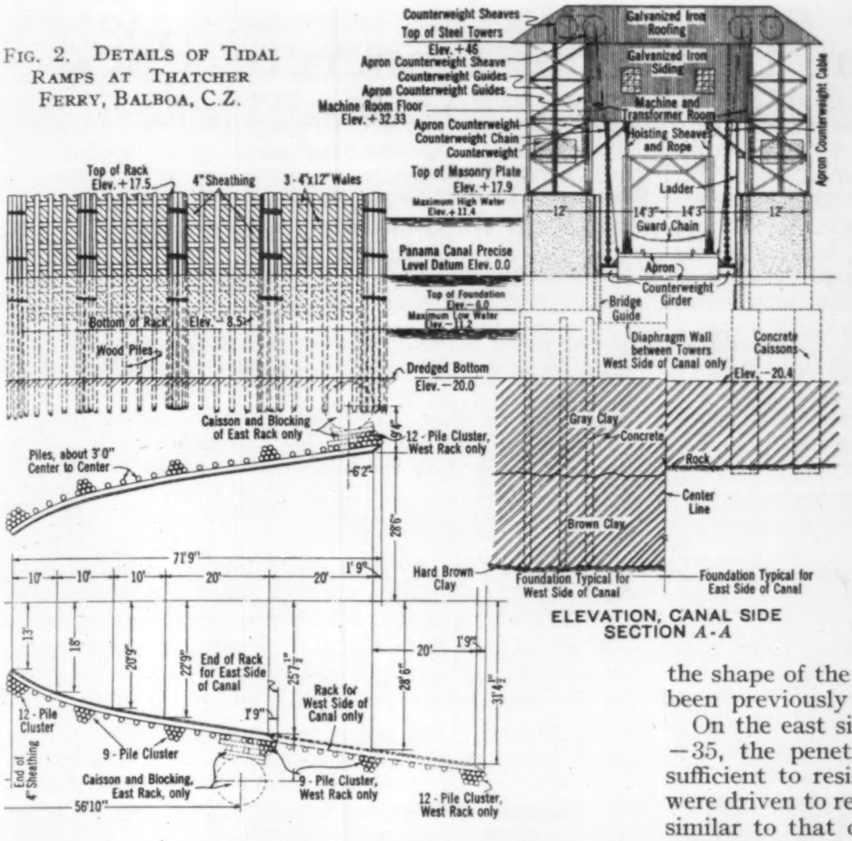

Counterweight Sheaves
Top of Steel Towers
Elev. +46
Apron Counterweight Sheave
Counterweight Guides
Apron Counterweight Guides
Machine Room Floor
Elev. +32.33
Apron Counterweight
Counterweight Chain
Counterweight
Top of Masonry Plate
Elev. +17.9
Maximum High Water
Elev. +11.4
Panama Canal Precise
Level Datum Elev. 0.0
Top of Foundation
Elev. −6.0
Maximum Low Water
Elev. −11.2
Dredged Bottom
Elev. −20.0
Galvanized Iron Roofing
Galvanized Iron Siding
Machine and Transformer Room
Hoisting Sheaves and Rope
Ladder
12'
14'3"
14'3"
12'
Guard Chain
Apron
Counterweight Girder
Bridge Guide
Diaphragm Wall between Towers West Side of Canal only
Concrete Caissons
Elev. −20.4
Apron Counterweight Cable
Gray Clay
Concrete
Rock
Center Line
Brown Clay
Hard Brown Clay
Foundation Typical for West Side of Canal
Foundation Typical for East Side of Canal
ELEVATION, CANAL SIDE
SECTION A-A
Top of Rack
Elev. +17.5
4" Sheathing
3 - 4"x12" Wales
Bottom of Rack
Elev. −8.5
Wood Piles
Caisson and Blocking of East Rack only
12 - Pile Cluster, West Rack only
Piles, about 3'0" Center to Center
6'2"
28'6"
71'9"
10'
10'
10'
20'
20'
1'9"
13'
18'
20'9"
22'9"
End of Rack for East Side of Canal
25'7½"
1'9"
Rack for West Side of Canal only
28'6"
20'
1'9"
31'4½"
12 - Pile Cluster
9 - Pile Cluster
End of 4" Sheathing
Caisson and Blocking, East Rack, only
9 - Pile Cluster, West Rack only
12 - Pile Cluster, West Rack only
56'10"

Fig. 2. Details of Tidal Ramps at Thatcher Ferry, Balboa, C.Z.

seat for the water end of the ramp when repairs or adjustments are being made. Their location is shown in the illustrations on page 63 and on the cover.

While the floating cranes, *U.S. Ajax* and *U.S. Hercules*, have a capacity of 250 long tons with the arm 20 ft over the side or end of the crane, their capacity at a reach of 80 ft is reduced to 100 long tons. The water was so shallow alongside the sites for the ramps that the cranes had to operate from the dredged ferry slips at the end of the ramps. The estimated weight of each ramp, without the apron but including the timber flooring, was 125 short tons, for which load the maximum allowable reach of the cranes was only 75 ft, this reach being insufficient to land the ramp on its permanent supports. A temporary timber trestle of two bents of short piles on mud sills was required to support the land end of each ramp before it was rolled on to the abutment. The dead-load reaction was distributed by temporary timbers placed on the under side of the ramp.

The crane hoisted the ramp off the barge, on which it had been towed to the site, and set the land end on a series of 4-in. pipe rollers on the temporary trestle, and the outer end on cribbing laid on the 20-in. I-beams that projected from the gallows frame foundation. The slings from the crane to the pins at panel point U 2 of both trusses were then unfastened, and the outer end of the ramp was lifted off the cribbing at the gallows-frame foundation while the land end was rolled along the trestle structure until the end casting was directly over the anchor bolts. Then the land end was jacked down and the outer end was lowered to the cribbing on the 20-in. I-beams.

Placing of the gallows frame was an easier operation because the floating crane was able to lift the frame off its barge and lower it over the anchor bolts without difficulty. As may be seen in the accompanying photographs, part of the counterweight and hoisting equipment was placed on the gallows frame before it was removed from the dock. After the gallows frame had been placed on its foundation, the concrete slab for the machinery-room floor and the concrete ramp counterweights were poured. These counterweights were poured on blocking, which also rested on the 20-in. I-beams, at such elevation that the ramp could be jacked up 3 in. and connected to the counterweight chain. Finally, the counterweight and hoisting mechanisms were adjusted. The ramp was opened for traffic on September 1, 1932.

CAISSONS REINFORCE RECEIVING RACK

On the west side, where rock is at elevation −50, the receiving rack for the ferry boat consists of individual piles spaced 3 ft on centers and clusters (of 9 piles each) placed 20 ft on centers, held together by horizontal waling strips and 4 by 12-in. sheathing placed diagonally, as shown in Fig. 2. The rack is curved in plan to conform to the shape of the boat. All timbers and piles used had been previously given a 14-lb creosote treatment.

On the east side, however, where rock is at elevation −35, the penetration of the piles was considered insufficient to resist the impact of the ferry boat. Piles were driven to refusal and the rack structure constructed similar to that on the west side, except that two steel cylindrical shells, $^3/_8$ in. thick and 9 ft 7 in. in diameter, were sunk to bedrock and filled with concrete poured under water. One was located on the outside of each arm of the rack, near the outer end.

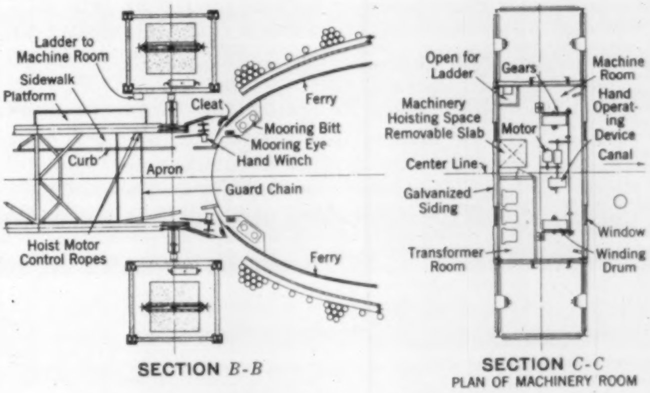

Ladder to Machine Room
Sidewalk Platform
Cleat
Ferry
Mooring Bitt
Mooring Eye
Hand Winch
Curb
Apron
Guard Chain
Hoist Motor Control Ropes
Ferry
SECTION B-B
Open for Ladder
Gears
Machine Room
Hand Operating Device
Machinery Hoisting Space Removable Slab
Motor
Center Line
Canal
Galvanized Siding
Window
Transformer Room
Winding Drum
SECTION C-C
PLAN OF MACHINERY ROOM

Fig. 3. Sections *B-B* and *C-C* of Fig. 2

Completion of the Thatcher Ferry and Highway was accomplished through the coordinated efforts of the Municipal Engineering Division (G. W. Green, Municipal Engineer), the Dredging Division (J. G. Claybourne, M. Am. Soc. C.E., Superintendent), the Mechanical Division (R. W. Ryden, Captain, U.S. Navy, Superintendent), and the Section of Office Engineer (L. W. Lewis, Office Engineer), of The Panama Canal. During the period of design and construction, Harry Burgess, M. Am. Soc. C.E., Brigadier General, U.S. Army, was Governor; Julian L. Schley, M. Am. Soc. C.E., Lieutenant Colonel, Corps of Engineers, was Engineer of Maintenance; and J. C. Mehaffey, Major, Corps of Engineers, was Assistant Engineer of Maintenance.

Holding-Down Power of Concrete Piles

Results of Field Tests Made at Columbus, Ohio, on Square Precast Piles with Parallel Sides

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PILES are commonly thought of as providing a means of supporting loads and offering resistance to settlement. There are times, however, when they offer a satisfactory and economical method of holding down a structure subject to hydrostatic uplift. This article describes the results of field tests made at Columbus, Ohio, to determine the holding-down power of precast, reinforced concrete piles, so that a comparison of cost could be made between two designs for storm stand-by tanks, one with a heavy concrete bottom and the other with a lighter reinforced concrete bottom held down by piles. The tanks are now under construction in that city. As but few experiments are on record regarding the holding-down power of piles, the Columbus tests should prove of interest to engineers who deal with problems of hydrostatic uplift.

AS a part of its sewerage and sewage disposal program, the City of Columbus, Ohio, has under construction several storm stand-by tanks as an adjunct to the intercepting sewers serving those parts of the city sewered on the combined system. On account of the location of these tanks, close to the Scioto River, where their bottoms would be well below high-water level in the river, it was early recognized that hydrostatic uplift would be an important factor in their design. Two methods suggested themselves for resisting this uplift, either the use of thick concrete bottoms of sufficient weight, or a system of concrete piles to which tank bottoms of lesser thickness would be anchored, the piles being designed to resist upward pressure.

Studies were undertaken to determine which of these two methods would be the more economical. A design embodying a thick concrete bottom offered no problems, but one using concrete piles was a different matter for the reason that data on the holding-down power of piles subject to upward pull were meager. It was decided, therefore, before designing the tanks, to make field tests on the holding-down power of full-sized piles. Although the tests were limited in number, it is thought that this brief description of the apparatus used, the tests made, and the results obtained, will be of assistance to others facing a similar problem.

At the site of the tanks, the ground in general has an elevation of 11 ft above ordinary low water in the Scioto River and is subject to overflow when the river is high. In Fig. 1 are shown the subsurface conditions at the site. The data used were obtained from two wash borings located immediately adjacent to the excavation in which the test piles were driven, and about in the center of the area to be occupied by the tanks. This excavation was carried to the approximate elevation of the under side of an assumed reinforced concrete bottom for the tanks, so that the test piles would be driven in the same material as the piles for the tanks.

TABLE I. DATES OF MAKING, DRIVING, AND TESTING PILES

PILE NUMBER	LENGTH OF SQUARE SECTION OF PILE, IN FT.	DATES (1930)			ELAPSED TIME, IN DAYS	
		Making	Driving	Testing	Between Making and Driving	Between Driving and Testing
1. . . .	15	Feb. 18	Mar. 19	Apr. 17–18	30	29
2. . . .	15	Feb. 18	Mar. 19	Apr. 16–17	30	28
3. . . .	15	Feb. 18	Apr. 1	Apr. 9–10	41	8
4. . . .	15	Feb. 18	Apr. 1	Apr. 8–9	41	7
5. . . .	20	Feb. 20	Apr. 1	Apr. 10–11	39	9
6. . . .	20	Feb. 20	Mar. 31	Apr. 11–12	38	11
7. . . .	20	Feb. 20	Mar. 20	Apr. 14–15	28	25
8. . . .	20	Feb. 20	Mar. 20	Apr. 15–16	28	26

Other borings made on the site showed similar materials. In general, it may be said that the ground in which the piles were driven consisted of a mixture of sand and gravel, varying from a sandy gravel near the surface to a coarse gravel below. Excavations for deeper parts of the subsequent work confirmed the indications of the wash borings and disclosed the presence of occasional "one-man" stones.

The ground-water level at the site varies. At times of continued low water in the river, it is several feet below the under side of the tank bottoms. This condition precluded the use of timber piles.

The piles tested were of precast reinforced concrete, as shown in detail in Fig. 2, and were eight in number. All of them were 14 in. square and of uniform cross section, except for the tapered points, which were 18 in. long. Above the tapered point, four of the piles had a length of 15 ft and the

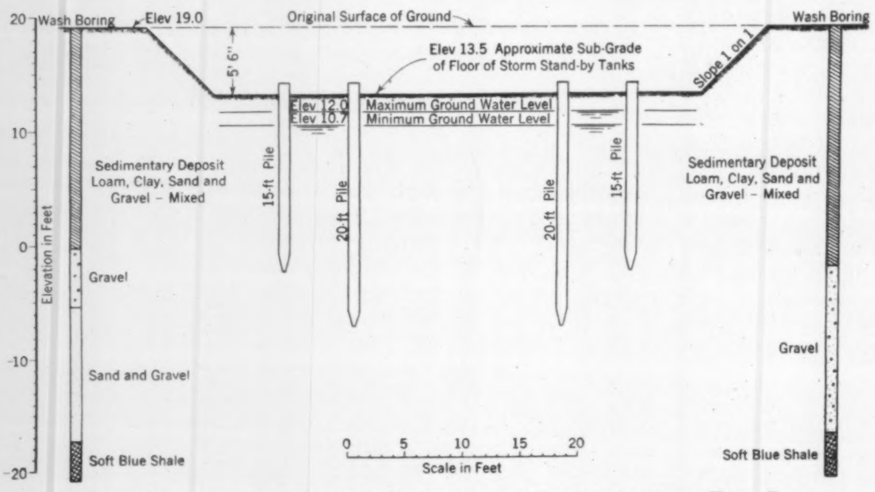
20
10
0
-10
-20
Elevation in Feet
Wash Boring
Elev 19.0
Original Surface of Ground
Wash Boring
5' 6"
Elev 13.5 Approximate Sub-Grade of Floor of Storm Stand-by Tanks
Slope 1 on 1
Elev 12.0 Maximum Ground Water Level
Elev 10.7 Minimum Ground Water Level
Sedimentary Deposit Loam, Clay, Sand and Gravel - Mixed
15-ft Pile
20-ft Pile
20-ft Pile
15-ft Pile
Sedimentary Deposit Loam, Clay, Sand and Gravel - Mixed
Gravel
Sand and Gravel
Gravel
Soft Blue Shale
0 5 10 15 20
Scale in Feet
Soft Blue Shale

FIG. 1. LONGITUDINAL SECTION THROUGH THE EXCAVATION FOR TEST PILES

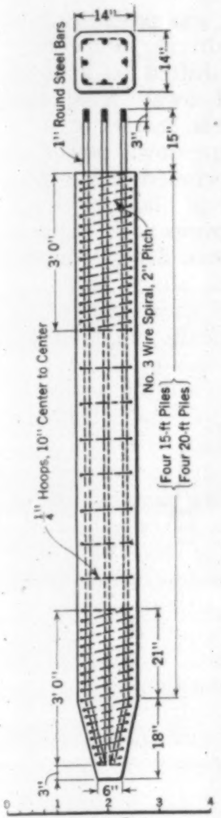
14"
14"
1" Round Steel Bars
3"
15"
3' 0"
No. 3 Wire Spiral, 2" Pitch
1/4" Hoops, 10" Center to Center
Four 15-ft Piles
Four 20-ft Piles
21"
3' 0"
18"
3"
6"
0 1 2 3 4
Scale in Feet

Fig. 2. Cross Section of Reinforced Concrete Test Pile and Plan of Pulling Plate

other four, a length of 20 ft. Concrete for the piles was mixed by machine in the proportion of one part of quick-setting cement, two parts of fine aggregate, and three parts of coarse aggregate, measured by volume, together with sufficient water to give a slump of 6 in. The mixing time was not less than 3 min.

The vertical steel reinforcement for each pile consisted of eight 1-in. round bars extending from a point 3 in. above the tip of the pile to 15 in. above the butt, with the upper 3 in. threaded for attachment to the testing apparatus. The circumferential reinforcement at the top and bottom of each pile extended for a length of 3 ft and consisted of a No. 3 (Birmingham Wire Gage) wire spiral with a 2-in. pitch. Intermediate circumferential reinforcement was of $^1/_4$-in. round-bar hoops spaced 10 in. apart. The steel reinforcement bars were of intermediate-grade open-hearth steel, and met the requirements of the Standard Specifications for Billet Steel Concrete Reinforcement Bars, Serial Designation A15-14, of the American Society for Testing Materials.

The piles were cast in a horizontal position, in forms made of surfaced lumber and were cured for a period of at least seven days at a temperature of not less than 40 F. Exposed surfaces were kept moist for five days. After the forms were removed, the pile surfaces were carefully examined, all projecting fins were removed, and rough places were patched, so that the piles, when ready for testing, had uniform smooth surfaces. The dates of making, driving, and testing the piles are given in Table I.

It was originally intended to drive four of the piles, two of each length, with a steam hammer, and to drive the other four with a water jet. A single-acting steam hammer was used to drive the first four piles, of which Nos. 1 and 2 were 15 ft long, and Nos. 7 and 8 were 20 ft long. The hammer used had a ram weighing 3,000 lb and a stroke of 36 in. All attempts to drive the next three piles with a water jet alone were unsuccessful. With a 1-in. nozzle, delivering about 250 gal per min under a pressure of 65 lb per sq in., pile No. 3, 15 ft long, and piles Nos. 5 and 6, 20 ft long, could only be driven about 4 ft; consequently, the steam hammer was used to drive them the rest of the way. No attempt was made to use a jet on the last pile, No. 4, which was 15 ft long; it was driven entirely by steam hammer. The number of hammer blows per inch of penetration for the last foot of driving for each pile, and its condition after driving, are given in Table II.

Details of the testing apparatus are shown in Fig. 3. The two girders acted together as a lever, the two screw jacks serving as the fulcrum and the hydraulic jack as the lifting force. Two parallel rows of timber piles driven outside the limits of the excavation for the test piles, and capped with continuous 12 by 16-in. timber caps, were provided to support the testing apparatus. The timber piles in each row were 3 ft apart.

The hydraulic jack was equipped with a gage showing the total pressure exerted by it in tons. The gage was calibrated by placing the jack in a compression testing machine, applying known loads to the jack, and reading the gage. As a further check, the gage alone was calibrated with a standard gage tester. The screw jacks were provided so that it would be possible to keep the girders level during a test and to compensate for the compression of the timber caps.

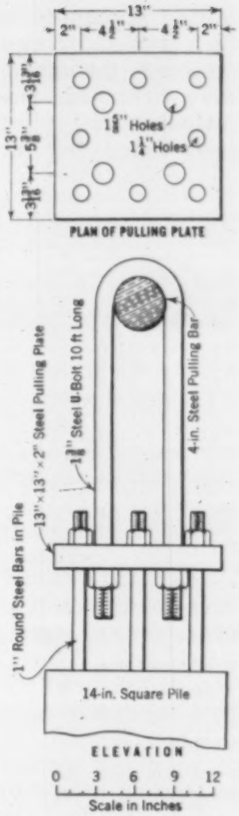
13"
2" 4½" 4½" 2"
3 1/16"
5 7/8"
3 1/16"
13"
1⅜" Holes
1¼" Holes
PLAN OF PULLING PLATE
13"×13"×2" Steel Pulling Plate
1⅜" Steel U-Bolt 10 ft Long
4-in. Steel Pulling Bar
1" Round Steel Bars in Pile
14-in. Square Pile
ELEVATION
0 3 6 9 12
Scale in Inches

Fig. 4. Cross Section, Showing Method of Connecting a Pile to the Testing Apparatus

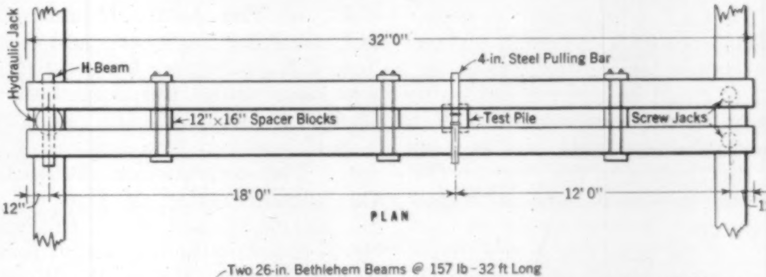
Hydraulic Jack
H-Beam
32' 0"
4-in. Steel Pulling Bar
12"×16" Spacer Blocks
Test Pile
Screw Jacks
12"
18' 0"
12' 0"
12"
PLAN
Two 26-in. Bethlehem Beams @ 157 lb - 32 ft Long
6' 0"
10' 0"
10' 0"
6' 0"
A
A
6-in. Carnegie H-Beam @ 20 lb
3"×12" Clamp Blocks
¾" Tie Bolts
One 25-Ton Hydraulic Jack
Spacer Block
12"×16" Pile Cap
SECTION A-A
Two 15-Ton Screw Jacks
Filler Block under Each Jack
Two 1⅜" U-Bolts
Pulling Plate
25-ft Wood Piles
3' 0" Center to Center
0 2 4 6 8 10
Scale in Feet
Test Pile
Test Pile
ELEVATION

Fig. 3. Layout and Details of Pile Testing Apparatus

Each test pile was connected to the testing apparatus by means of a pulling plate, two 1$^3/_8$-in. U-bolts, and a pulling bar 4-in. in diameter, as shown in Fig. 4.

To make a test, the girders, pulling bar, and U-bolts were carefully centered over the pile to be tested, and the pulling plate was then lowered over the round bars projecting from the pile lead. Next, the plunger of the hydraulic jack was raised slightly and the gage read. From this reading the dead load due to the weight of the testing apparatus was determined. The girders were then leveled by means of the screw jacks, after which procedure the nuts on the round bars and on the U-bolts were tightened, care being taken to keep the pulling plate level and to get approximately the same tension on each round bar without appreciably increasing the load on the hydraulic jack. The horizontal distances from the center of the pulling bar to the centers of the hydraulic and screw jacks were carefully measured with a steel tape; a level rod was clamped in a vertical position to the head of the pile; and readings on the rod were taken with a wye level.

TABLE II. DATA ON THE DRIVING OF TEST PILES

PILE NUMBER	LENGTH OF PILE, IN FEET			METHOD OF DRIVING	NUMBER OF HAMMER BLOWS PER INCH OF PENETRATION FOR LAST FOOT	CONDITION OF PILE AFTER DRIVING
	Total	Total of Square Section	Square Section Below Ground			
1	16.5	15	11	Driven by hammer to refusal	70	Tipped slightly
2	16.5	15	14	Driven by hammer	25	Vertical
3	16.5	15	14	Jetted 4 ft.; remainder driven by hammer	25	Vertical
4	16.5	15	14	Driven by hammer	25	Tipped slightly
5	21.5	20	19	Jetted 4 ft.; remainder driven by hammer	30	Vertical
6	21.5	20	19	Jetted 4 ft.; remainder driven by hammer	30	Tipped slightly
7	21.5	20	19	Driven by hammer	50	Tipped badly
8	21.5	20	19	Driven by hammer	40	Vertical

When this preliminary work had been completed, pressure was applied to the hydraulic jack until a pull amounting to approximately 100 lb per sq ft of buried surface area had been applied to the pile. This load was maintained for four hours, during which period gage and rod readings were taken at frequent intervals. In order to maintain a constant pressure, it was usually found necessary to apply additional pressure to the hydraulic jack from time to time, because the valves in the jack leaked slightly.

At the end of the first 4-hr period, the pull on the pile was increased to approximately 200 lb per sq ft of buried surface area and then held constant for another 4 hr. This procedure was repeated every 4 hr until some movement of the pile was detected by the rod readings, the load being increased for each 4-hr period in increments of approximately 100 lb per sq ft of buried surface area. The average time required for one test was 24 hr.

The end point of each test could be determined quite accurately for two reasons: a movement of 0.002 ft could be easily detected with the wye level, and as soon as the pile began to move the reading of the gage on the hydraulic jack could not be increased even by rapid operation of the pressure pump.

The holding-down power of the piles due to frictional resistance varied from a minimum of 507 to a maximum of 722 lb per sq ft of buried surface area. The low result obtained with pile No. 7, a 20-ft pile, was probably due to the fact that it was tipped badly in driving, and consequently as the pull was applied it shifted to a more nearly vertical position and pulled away from the ground on one side, thus decreasing the surface area in contact with the ground. The holding-down power of this pile was included in computing the average holding-down power of the group, as it was felt that, if piles were driven for the bottoms of the storm stand-by tanks, some of them might not go down vertically, and consequently the inclusion of this test would give a result more nearly representative of the conditions that would obtain in actual construction.

It is interesting to note that, as shown in Table III, the holding-down power of the piles per square foot of buried surface area seemed to increase with the length of the pile below ground, although the tests are hardly sufficient in number to warrant the drawing of any definite conclusions on this point.

As a result of these tests, it was decided to use the lighter type of reinforced concrete construction for the bottoms of the storm stand-by tanks, with piles to resist the hydrostatic uplift. Exclusive of engineering, the cost of the tests was as follows:

Excavation	$ 540
Furnishing and installing the pumping equipment	1,730
Timber piles and caps, complete, in place	1,418
Furnishing the concrete test piles	2,064
Driving and jetting the concrete test piles	516
Testing the concrete piles	102
Total	$6,370

The tanks are now under construction by the Division of Engineering, Department of Public Service, City of Columbus, Ohio, of which R. H. Simpson, M. Am. Soc. C.E., is Chief Engineer; John H. Gregory, M. Am. Soc. C.E., of The Johns Hopkins University, Baltimore, is Consulting Engineer; and Robert A. Allton, M. Am. Soc. C.E., is Sewage Disposal Engineer. The field work was done under the immediate direction of James H. Blodgett, Assoc. M. Am. Soc. C.E., assisted by William J. Seidensticker, Jun. Am. Soc. C.E., and W. P. Hambleton. The construction of the tanks was begun under the administration of James J. Thomas, Mayor, and W. H. Duffy and R. S. McPeak, Directors of Public Service, and is being carried forward under the present administration, Henry W. Worley, Mayor, and W. P. Halenkamp, Director of Public Service.

TABLE III. RESULTS OF PILE-PULLING TESTS

PILE NUMBER	LENGTH OF SQUARE SECTION IN FT		DEPTH OF PILE BELOW GROUND WATER In Ft	TOTAL WEIGHT OF PILE In Lb	LOSS OF WEIGHT DUE TO SUBMERGENCE In Lb	NET WEIGHT OF PILE In Lb	TOTAL PULL TO START PILE UPWARD In Lb	NET UPWARD PULL—TOTAL PULL LESS NET WEIGHT In Lb	BURIED SURFACE AREA OF SQUARE SECTION In Sq Ft	HOLDING-DOWN POWER Due to FRICTIONAL RESISTANCE In Lb per Sq Ft of Buried Surface Area
	Total	Below Ground								
1.	15	11	9.7	3,290	927	2,363	29,000	26,637	49.5	538
2.	15	14	12.7	3,290	1,178	2,112	34,325	32,213	63.0	511
3.	15	14	13.75	3,290	1,265	2,025	42,400	40,375	63.0	641
4.	15	14	14.0	3,290	1,286	2,004	34,650	32,646	63.0	518
5.	20	19	18.5	4,430	1,675	2,755	52,100	49,345	85.5	577
6.	20	19	18.2	4,430	1,650	2,780	57,990	55.210	85.5	646
7.	20	19	17.7	4,430	1,608	2,822	46,240	43,418	85.5	507
8.	20	19	17.7	4,430	1,608	2,822	64,560	61,738	85.5	722
1–8									(Average of 8 piles)	582
1.	15	11							(One pile)	538
2, 3, 4	15	14							(Average of 3 piles)	557
5, 6, 7, 8	20	19							(Average of 4 piles)	613

Irrigation in Persia by Kanáts

An Ancient Method of Collecting and Conducting Water in Long Underground Galleries in Use Today

By Millard A. Butler
Member American Society of Civil Engineers
Consulting Engineer, Norfolk, Va.

IN modern times little has been written about the kanát, that ancient Persian or Arabic structure for collecting underground water to be used for irrigation. The kanáts, or artificial underground channels, start in the foothills where ground water is abundant and conduct it for long distances and sometimes at great depths until they reach the surface of the low-lying land to be irrigated. Since 800 B.C. thousands of miles of these collecting galleries have been laboriously built by hand, with crude equipment, to make agriculture possible in a sun-baked but fertile land. During Colonel Butler's residence in Persia on professional engagements, he had opportunity to study the history of the kanát system of irrigation, both ancient and modern. He here records his observations for the benefit of readers.

RUINS of ancient civilizations show the results of man's struggle for existence. Generally speaking, these ruins are in comparatively small, naturally fertile areas that are isolated and guarded by surrounding mountains or desert. Then, as today, the existence of man was dependent upon a sufficient supply of water and upon protection from unfriendly neighbors. The watered areas were cultivated; towns were built and fortified; communicating trails were established; and neighboring kindred peoples were allied for mutual protection and benefit.

Increase in population and the consequent need for additional watered land upon which to produce food caused man to use his ingenuity. The first engineers were developed in Samarkand, Haraiva, Ecbatana, Susa, Ur, Babylon, Nineveh, Thebes, and Memphis (Fig. 1). In the Samarkand–Haraiva areas to the northeast, the everflowing streams, having their source in the mountains of "the Roof of the World," provided a never ceasing and abundant supply of water, which was easily diverted by wicker and stone dams or dikes and carried in ditches to the adjoining steppe. Thus the Seistan, with less than 2 in. of rainfall, became one of the bread baskets of the world.

The delta of the Tigris and the Euphrates rivers, which includes the countries of Susa, Ur, Babylon, and Nineveh, extends from the head of the Persian Gulf for a distance of over seven hundred miles to the northwest and has an average width of two hundred miles. Both these streams are typical delta rivers having numerous channels with low banks, so that it was easy to conduct the water to neighboring lowlands through ditches. A part of the area was flooded each spring in much the same manner as the Nile Valley, leaving the soil in such condition that little additional water was necessary in order to produce a crop. The ancestors of Abraham learned that by throwing up dikes they could impound sufficient water during the period of high water to irrigate quite extensive areas until the crops matured. Masonry diversion dams were constructed in the more favorable locations and water wheels were devised for raising the water from the streams and discharging it into the irrigation ditches, thereby bringing large desert and semidesert areas under cultivation.

Modern Persia (Fig. 1) consists of the westerly three-fourths of the Iran Plateau and the littorals of the Caspian Sea and Persian Gulf, together with a small part of the Tigris-Euphrates delta. It has an area as large as all the United States east of the Mississippi and south of the Ohio River, together with Pennsylvania, New Jersey, New York, and New England, but its population is probably slightly less than that of New York State. Ancient Persia proper may generally be considered as consisting of the same area, together with the Afghan-Baluch parts of the plateau, a fringe of the Turkoman Steppe, and a larger section of the Tigris-Euphrates delta.

The plateau is a great bowl draining into the interior. It varies in elevation from about 900 ft above sea level in the "Lut," or great sink in the southeast, to 6,000 ft or more in the vicinity of Hamadan and Sultanabad. The northern rim of the bowl is in the lofty Elburz range, which extends around the southern end of the Caspian Sea and thence to the eastward to join the Afghan Mountains. The eastern rim is in the ridges of Afghanistan and Baluchistan, and the southern and western rims are in the Zargos Mountains. These mountains consist of a system of 11 or more parallel ranges which extend from Mount Kuh-i-Taftan, an 18,000-ft peak near the Baluchistan border, in a northwesterly direction parallel to the Persian Gulf, to Mount Ararat, 17,000 ft high, which marks the extreme northwestern corner of the country.

Accurate meteorological data for this region are not available, but the estimates in Table I, obtained from various consular reports, probably indicate the average precipitation quite correctly.

TABLE I. AVERAGE ANNUAL RAINFALL AT POINTS IN PERSIA

LOCALITY	RAINFALL
The Caspian Provinces, except in the vicinity of Astrabad (generally distributed throughout the year)	42–97 in.
Tabriz (ancient Tarus)	21.50 in.
Hamadan (ancient Ecbatana)	19.50 in.
Astrabad	16.28 in.
Teheran (ancient Rhagae)	9.53 in.
Ahwaz (ancient Susa or Shushan)	9.44 in.
Meshed (ancient Nishapur)	9.22 in.
Samarkand	6.21 in.
Isfahan (ancient Pasargadae)	4.49 in.
Seistan (ancient Haraiva)	1.88 in.

With the exception of the Caspian Provinces, practically all the rainfall is in the three winter months, and on account of the rapid run-off the streams are dry for the remainder of the year. The tillable lands are generally located in the valley bottoms some distance from the mountains. When the streams dried up, in the summer, the only available sources of water were wells sunk in or near the stream beds. In time it was found that in places the underlying sweet water extended over large areas and that wells sunk to the proper depth in clay or non-water-bearing strata could be connected with the water-bearing areas by drifts or tunnels. Eventually some one conceived the idea of connecting a series of dry wells with tunnels, and thus gradually bringing the water to the valley surface. Today these systems of *kariz*, as they are known in Persian—or *canat, ghanat, quanat*, or *kanát*, as various writers have euphoneously translated the Arabic—furnish the necessary water for supporting more than one-half the population.

The most ancient mention of irrigation probably occurs in the Code of Hammurabi I, King of Babylon about 2300 B.C., the prologue of which reads in part as follows:

> Hammurabi, the Prince . . . who conquered the four quarters of the world, made great the name of Babylon . . .; the lord who granted new life to Uruk [Biblical Erech, modern Irak], who brought plenteous water to its inhabitants; . . . who broadened the fields of Dilbat, who heaped up the harvests of Urash; . . . beloved of Ninni am I . . . .

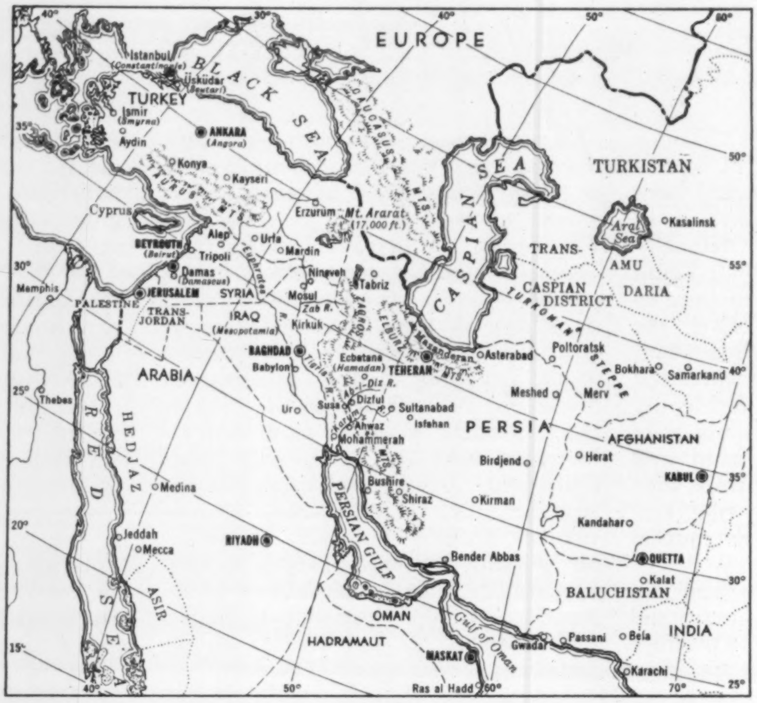
EUROPE
BLACK SEA
Istanbul (Constantinople)
Üsküdar (Scutari)
TURKEY
Ismir (Smyrna)
Aydin
ANKARA (Angora)
Konya
Kayseri
TAURUS MTS.
CAUCASUS MTS.
Erzurum
Mt. Ararat (17,000 ft.)
Cyprus
BEYROUTH (Beirut)
Tripoli
Alep
Urfa
Mardin
Euphrates
Damas (Damascus)
JERUSALEM
SYRIA
PALESTINE
Memphis
TRANS-JORDAN
IRAQ (Mesopotamia)
Nineveh
Mosul
Zab R.
Kirkuk
Tabriz
ZAGROS
ELBURZ
BAGHDAD
Babylon
Tigris R.
Ecbatana (Hamadan)
TEHERAN
Mazanderan
Diz R.
Ab-i-
Dizful
Susa
Karun R.
Ahwaz
Mohammerah
Ur
ARABIA
Thebes
RED SEA
HEDJAZ
Medina
Jeddah
Mecca
RIYADH
ASIR
PERSIAN GULF
OMAN
HADRAMAUT
MASKAT
Ras al Hadd
Gulf of Oman
CASPIAN SEA
TURKISTAN
Aral Sea
Kasalinsk
TRANS-CASPIAN DISTRICT
AMU DARIA
TURKOMAN STEPPE
Asterabad
Poltoratsk
Bokhara
Samarkand
Meshed
Merv
Sultanabad
Isfahan
PERSIA
AFGHANISTAN
Herat
Birdjend
KABUL
Bushire
Shiraz
Kirman
Kandahar
Bender Abbas
QUETTA
Kalat
BALUCHISTAN
INDIA
Gwadar
Passani
Bela
Karachi
40°
30°
50°
60°
70°
35°
25°
20°
15°
55°

FIG. 1. MODERN PERSIA AND SURROUNDING COUNTRIES

The earliest mention of the kanát is probably in the description of the canal and tunnel of Negoub, constructed about 800 B.C. to convey the waters of the River Zab to Nineveh. In 626 B.C. the Medes besieged Ecbatana (modern Hamadan) and effected its capture by destroying the kanáts and cutting off the water supply.

Darius I was king from 521 to 485 B.C. In 512 B.C. he conquered the Punjab, aided by the Caryandan Admiral Scylox, who perhaps should be known as the Father of Engineers. Later Admiral Scylox went to the Oasis of El Khargeh in Egypt, a depression about one hundred miles long, containing 1,800 sq miles of productive land when irrigated, and in the terms of an inscription, "Introduced the Persian method of irrigation by means of underground conduits fed by water from the strata of sandstone where it collected in faults." In this way he increased the productive area of the oasis to such an extent that the Temple of Ammon at Hebis was built in commemoration of the accomplishment and the Egyptians, who had never previously willingly recognized the Persian conqueror as king, conferred the title of Pharaoh on Darius.

In the course of time, the outlets of these kanáts suffered through the action of the elements and conquest. In modern times, until quite recently, those still flowing were thought to be natural springs. The investigation which followed the translation of the inscriptions revealed their true nature. They have been partially explored, but their total length is as yet unknown. As the entire district is practically rainless, the kanáts must extend far enough eastward to intercept the seepage from the Nile. This being true, and there being over one hundred miles of intervening rolling desert, how did Scylox know or determine that the elevation of the oasis was low enough to permit the flow of the accumulated water by gravity?

In describing the war between Antiochus the Great and Arsaces III, King of the Parthians (211–205 B.C.), Polybius says:

> Arsaces expected that Antiochus would come as far as the district of Media, but would not venture across the desert with a large force, because of the scarcity of water. For in this area there is no water on the surface, though there are many subterranean channels with well shafts sunk to them at spots in the desert unknown to strangers. When however Arsaces saw that Antiochus was determined to cross the desert, he endeavored at once to destroy the wells.

Today this method of obtaining water for irrigation is in general use in most countries that have been under Arabic domination or influence. In Afghanistan and Central Asia, where the kanáts are known as *kariz* or *kahriz*, and in Baluchistan, where they are termed *kanáts*, they are used on a scale nearly equal to that in Persia. The kanáts are numerous in Yemen, Arabia, where they are called *shariz*, and are used to some extent in Syria, mostly in the vicinity of the Djebel Druze Mountain and near Rutbah (where Rebekah went to the well). I observed new ones under construction when passing through there in 1928. They are used extensively in the province of Tidikelt, in Ghardia in Algeria, and in the Taut region of the Sahara, where they are called *foggariur*. According to Gauthier, in the Taut region alone there are 1,200 miles of these tunnels. They are also numerous in the Oasis of Menchico and in the province of Nefzua in southern Tunis, as well as in Morocco, where they are termed *shat-at-ir*. Their use

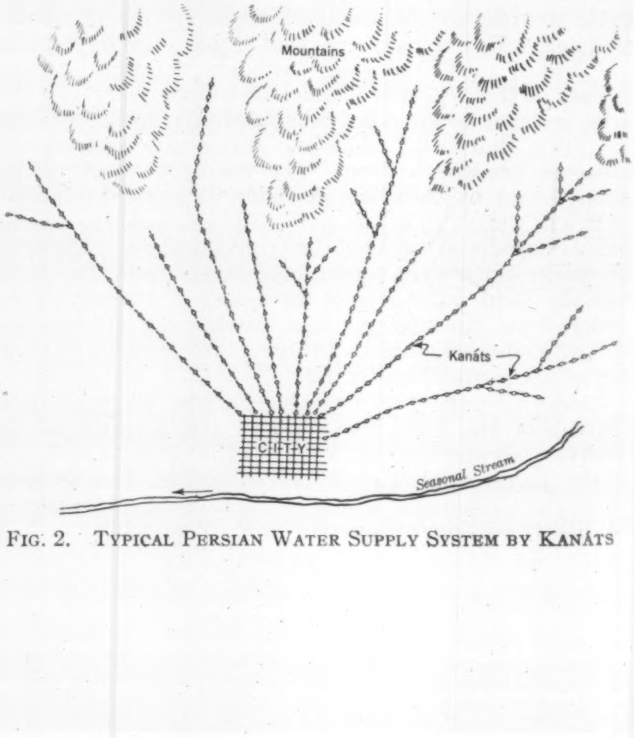
Mountains
Kanáts
CITY
Seasonal Stream

FIG. 2. TYPICAL PERSIAN WATER SUPPLY SYSTEM BY KANÁTS

has also spread to the New World, where they are found in the desert regions along the western coast of South America.

WATER SUPPLY FOR TEHERAN

The entire water supply for the city of Teheran, which has a population of 275,000, for the suburb of Shah Abdul Azim, 6 miles from the city wall, and for the intervening irrigated agricultural area, is obtained from 36 kanáts. They are from 8 to 16 miles in length and in places over 500 ft below the surface. Those coming to the surface at Shah Abdul Azim pass more than 200 ft below the level of the city of Teheran. A typical Persian kanát system is shown in Fig. 2.

These kanáts have their sources in the gravel beds along the foot of the Elburz Mountains about 8 miles north of the city, which are very precipitous on their southern slopes. The precipitation occurs almost entirely in the winter. Run-off is very rapid, and most of the streams are dry in summer. The kanáts originating in the beds directly opposite the city, pass down the valleys and are quite near the surface. Those originating in the more distant beds pass under intervening moraine ridges at maximum depths of about 700 ft.

Above the city, the formation consists almost entirely of a hard conglomerate composed principally of limestone and shale cobbles and gravel. Under the city and between it and Shah Abdul Azim, are areas of clay, sand, and silt. In the conglomerate and harder clay the kanáts are unlined; elsewhere they are lined with brick or with burned tile, some of which are $3^1/_2$ ft in diameter. Most of them were constructed as private enterprises two hundred or more years ago. Some are reputed to have cost more than 100,000 tomans, which at that time was much more than $100,000, the present equivalent for the same sum. The municipality now owns all of them, excepting one which is owned by the British Government and reaches the surface in the British legation. This one has covered shafts, but the others—except in the city, where they are covered with stone slabs—are open and the only protection is the ring of detritus. Their combined flow in autumn is approximately 3,300,000 gal per day, and in the spring it is probably more than double that amount.

In commenting on farm kanáts for irrigation, the Opium Commission Report to the League of Nations for the year 1926, page 23, states that "the average length of kanáts in desert regions is 25 to 28 miles, otherwise $1^3/_4$ miles." In other words, using a minimum grade in the tunnel, on the sloping bottom of the bowl, it requires from 25 to 28 miles to bring the ground water to the surface. A profile and a cross section of a kanát are shown in Fig. 3, indicating the method of bringing the grade of the tunnel out to the ground surface.

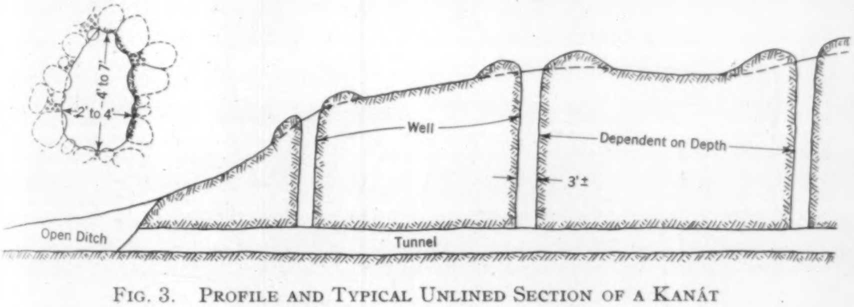

FIG. 3. PROFILE AND TYPICAL UNLINED SECTION OF A KANÁT

Variable Gradient Depends Somewhat on Ground Surface. Where the Material Will Not Stand by Itself, the Galleries Are Occasionally Lined with Brick or Tile

Isfahan, the third city of the kingdom, with a population of 250,000, is situated on the Zindeh Rud River near the north end of a valley about 400 miles long and from 15 to 60 miles wide. The valley is separated from the interior bowl by the Kurgiz Mountains, which are the most easterly range of the Zargos system. The Zindeh Rud, having its source in some of the higher snow clad ridges of the Zargos, has a large flow of water the year round. The upper part of the valley is irrigated in part by water taken from the river and in part by water secured from a quite extensive system of kanáts. One of these in the vicinity, having its source near the foot of Kuh-i-Kurgiz, is said to be 56 miles long.

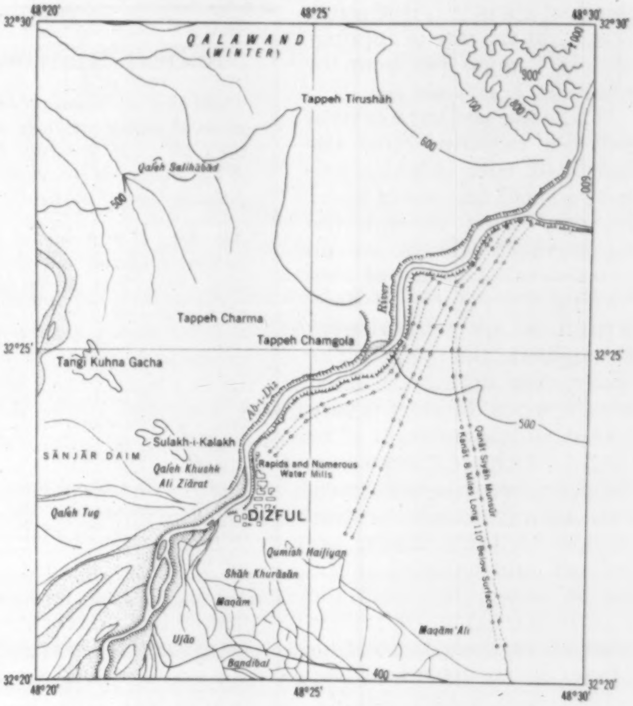

FIG. 4. SHOWING THE DUAL KANÁTS SUPPLYING IRRIGATION WATER NEAR DIZFUL, PERSIA

These Underground Collecting Galleries Make Diversions from the Ab-I-Diz

On the east side of the Ab-i-Diz, to the south of Dizful, there is a large area that has been irrigated since time immemorial, in part by waters taken directly into the surface ditches from the Ab-i-Diz [River] and in part by water furnished by kanáts, as may be seen in Fig. 4. The heads of the ditches are in the gravel bars along the east side of the river, about two miles below the city. Since there are no permanent diversion works and the river at that point rises 25 ft or more each winter, the upper part of the ditches and the brush and stone diversion dikes must be reconstructed after each period of high water.

There are six kanáts arranged in pairs. The three systems extend from the gravel bars on the banks of the Ab-i-Diz, about 7 miles above the city, to the flats below the city. The lower end of the shorter pair, which are about 6 miles long, passes directly under the city for a distance of nearly 2 miles. The longest pair, which have their outlet on the fertile plain about 5 miles southeast of the city, are slightly over 8 miles long and have a measured depth of 110 ft. The material underlying the city and throughout the entire length of the tunnels is a very hard lime and quartz pebble and cobble conglomerate, cemented with silica, lime, and natural cement. Each kanát is about 3 ft by 5 ft in section and normally carries a depth of about $2^1/_2$ ft of water flowing at the rate of approximately 2 miles per hour, or about $7^1/_2$ cu ft per sec.

There are said to be several galleries radiating from the last shaft, each of which collects a small amount of water by percolation through the hard gravel. There are no gates or other means of controlling the volume of flow, which is quite uniform throughout the year. The water, even during the flood season, when the river is very turbid, is clear and cold. The shafts, which are about 4 ft in diameter, are spaced at intervals approximately proportionate to their depth, are unlined, and have no covering or protection except the surrounding ring or hollow cone of excavated material. There is no record of the construction of these kanáts.

The inhabitants of the city and the neighboring tribes of "Uxians," or Lures, are said to be the only people that Alexander failed to subdue in his conquest of Persia. In the comments of the time, Dizful is referred to as "the city of rats," evidently because most of the houses extend from two to five or six stories below ground, although none of them is over two stories above ground. They are connected by a maze of passageways, and many of them have steps leading to the kanáts that pass underneath. In this hot desert country, fortunate is the house that can boast of a cooling kanát in its underground summer room.

In districts where the volume of the available water is small, single kanáts are usually constructed. This is especially true where the supply is dependent on the seepage from large areas, which is collected by wye or branch tunnels. In places where the available volume is practically unlimited, as at Dizful, the kanáts are constructed in pairs, with connecting galleries at frequent intervals, so that water can be diverted from one tunnel to the other to facilitate repairs. Ordinarily all the water is carried in one of the tubes and the other is held in reserve.

In ancient times, kanáts seem to have been constructed only in earth, clay, shale, sandstone, and conglomerate, and little or no attempt was made to penetrate the harder ledge rock.

CONSTRUCTION METHODS

In ancient and medieval times the great systems were probably built by captives taken in war and by slaves. Today the work is usually done by a guild known as *mukanni*, assisted by local coolie labor. Timbering is practically unknown, and the lining, if required, is placed as the excavation progresses. Muck and lining material is carried in a fold of burlap or a goat skin and is raised or lowered by a manually operated windlass having a hand wheel 6 ft or more in diameter. Accidents are frequent and the loss of life is correspondingly great.

Owing to the varying units of measure in use in the country and the fact that a considerable part of the labor is supplied as a form of tithe, without compensation, accurate cost data are not available. A kanát approximately 10,500 ft long and averaging 42 ft deep, constructed in Mazandaran in 1908, cost about $9,100.

Water for domestic purposes may be taken from a

ANCIENT BABYLONIAN IRRIGATION LAWS

All civil and criminal phases in the lives of a primitive pastoral people are fully covered in the many sections of the Code of Hammurabi I, King of Babylon about 2300 B.C., discovered at Susa in 1901. Among them the following are of particular interest:

Sec. 53. If any one be too lazy to keep his dam in proper condition, and does not keep it so; if then the dam breaks and all the fields are flooded, then shall he in whose dam the break occurred be sold for money and the money shall replace the corn which he has caused to be ruined.

Sec. 54. If he be not able to replace the corn, then he and his possessions shall be divided among the farmers whose corn he has flooded.

Sec. 55. If any one open his ditches to water his crop, but is careless, and the water flood the field of his neighbor, then he shall repay his neighbor with corn for his loss.

Sec. 56. If a man let out the water, and the water overflow the land of his neighbor, he shall pay 10 gur of corn for every 10 gan of land flooded.

Sec. 259. If any one steal a water wheel from a field he shall pay five shekels of money to its owner.

Sec. 260. If any one steal a shadduf [used to draw water from a river or canal] or a plough he shall pay three shekels in money.

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DRAWING WATER FROM A WELL FOR IRRIGATION PURPOSES

Two Oxen Operate Two Large Buckets Made from the Whole Hide of a Cow

© Keystone-Underwood

A SYRIAN WATER WHEEL IN ACTION

A One-Horsepower "Pump" Lift Not Unlike Those Existing at the Time of Hammurabi I kanát at all times, and under the religious law a man may build steps to a kanát passing under his property. Custom has construed this right to mean the use of the passing stream for the disposal of the family waste, resulting in conditions that to the occidental are impossible. Some kanáts were constructed under family partnerships, so that they have a large number of owners. Kanáts in the Yezd may have from 50 to 1,000 owners.

In Arabic the word kanát means lance or spear. Its application to the tunnel probably comes from the practice of laying a spear across the top of the shaft, pointed toward either the preceding or succeeding shaft, and dropping plumb bobs to give the direction of that section of the tunnel. After the bed of water-bearing ground has been located by a series of test wells or shafts, a mother shaft is sunk in the lower part of the area. The second shaft is then located in the direction of the nearest available low-lying, nearly level, tillable ground, and the tunneling is started. The distance between shafts varies with the depth and the material encountered.

As each section is completed, the alignment is varied to miss hills, rocky points, and villages, and to take advantage of the lower and easier ground. Levels are carried along the surface by means of a looped string suspended from a cross arm or tripod by a single strand, and having at the lower end a heavy weight. The sides of the loop are spread into a diamond by a stick or rod, the ends of which, when adjusted so as to sight along the same line when turned end for end, are level. In Fig. 5 the method of establishing the proper grade is shown.

Surprisingly accurate work can be done with this instrument, but the *mukanni* is only interested in practical results, so he drops a string to the bottom of the mother shaft and ties two knots in it, one at the ground surface and the other where his line of sight hits it. He then causes the string to be held over the site of the next succeeding shaft, so that the upper knot is in his line of sight, and places a knot at the ground surface. The remainder of the string, plus an allowance of an inch or so for grade, is the necessary depth of that hole. The same procedure is followed for each succeeding shaft. If the difference in elevation between two shafts is such that more than one set-up is required, the changes in ground elevation and height of instrument are all recorded by knots in the string. Obviously, if enough knots were made, the allowance for grade would not be sufficient to overcome the loss in length of the string because of the knots, and the kanát-grade would be uphill.

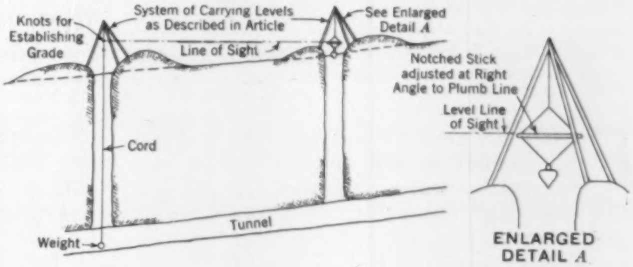

Knots for Establishing Grade
System of Carrying Levels as Described in Article
See Enlarged Detail *A*
Line of Sight
Notched Stick adjusted at Right Angle to Plumb Line
Level Line of Sight
Cord
Tunnel
Weight
ENLARGED DETAIL *A*

FIG. 5. METHOD OF ESTABLISHING THE GRADE OF A KANÁT
Notched Stick Made Level by Adjusting It to Sight on Same Point When Reversed End for End

When the bottom of a shaft is reached and tunneling has proceeded a short distance, a similar string level is dropped down the shaft so that the digger may know the relation between the hole he has started to the horizontal. As there is no system of ventilation, artificial light is used as little as possible, and the worker depends to a considerable extent on reflected sunlight, which, according to tradition, has been used since the earliest antiquity. Twists and turns are made around boulders, and one man digs a larger section than his neighbor. When the kanát is finished, one or two or perhaps several have been killed, but their sons and brothers carry on, "God willing." The water runs and every one is happy, "God be praised." Possibly the *mukanni* knows how much string it takes to make a knot.

The assistance of Joseph H. Moore, Assoc. M. Am. Soc. C.E., and D. F. Gibbony in the preparation of the diagrams and sketches is gratefully acknowledged.

GEORGE WESTINGHOUSE BRIDGE, PITTSBURGH, PA., LOOKING WEST

Of the five great concrete arches, the center 460-ft span rises 200 ft above Turtle Creek Valley and is the longest concrete arch in America. The approach to the east end of the bridge is through a 130-ft cut. Construction was completed in 1932 by Booth and Flinn Company, for the Allegheny County Department of Public Works, of which V. R. Covell, M. Am. Soc. C.E., is Chief Engineer of the Bureau of Bridges.

Influence of Overgrazing on Erosion and Watersheds

By H. H. CHAPMAN

HARRIMAN PROFESSOR OF FOREST MANAGEMENT, SCHOOL OF FORESTRY,
YALE UNIVERSITY, NEW HAVEN, CONN.

IN the great intermountain region of the United States, where the problems of erosion are most acute, there are 154 million acres of public land usable for grazing purposes, where the only natural force preventing erosion is the very vegetative cover which supports the grazing animals. The author of this article is convinced that too little control of grazing and of other agencies harmful to the natural cover is the cause of the rapid increase in erosion and flood damage in the intermountain region, just as improper methods of tillage for agricultural crops is responsible for the destruction of upward of 22 million acres of land formerly in cultivation. Engineering works alone cannot prevent such destruction or restore the protection afforded by nature. Erosion has destroyed in a generation soil that took 40 centuries to build. This soil is capable of filling storage reservoirs, burying farm land, and reducing the area of both farming and grazing country to such an extent as to definitely diminish the capacity of the country to support population. He suggests an intensive scientific study of the causes of erosion to determine means of control.

EROSION means the direct displacement of soil and its removal by water, followed by its subsequent deposition at lower levels, due to lessened velocity and consequent deposit of the burden of silt. This process, whether beneficial or detrimental, will have an effect in the field of food supply, or total acreage of arable land; in that of navigation, or river transportation; and in that of water storage, or power and irrigation. Of these fields the first is of interest more particularly to agriculturists, but the last two are definitely within the scope of engineering. The whole subject of erosion, however, is closely integrated. Destruction of farm land and excessive erosion of hillside pastures result directly in silting of streams and irrigation ditches, filling of reservoirs, and gradual destruction of values in engineering works of huge proportions.

There has been too great a tendency among engineers to concentrate on the works of man to the neglect of the works of nature. Biologists, farmers, foresters, and others who deal with natural processes at first hand are more observant of the working and balance of natural forces. They are more apt, not only to detect abnormal destructive tendencies, but also to diagnose the symptoms and prescribe a possible cure.

EROSION—A DETRIMENT OR A BENEFIT?

The question may be fairly asked: What beneficial results can follow from erosion? To this the entire farming industry, and with it unanimously the scientists of the U.S. Department of Agriculture and the state agricultural colleges and experiment stations, would answer: None whatever! It is true that the level character of our agricultural land is due to an age-old process by which soil was eroded from ancient mountains, transported to the ocean, deposited, and later elevated until it became dry land. On a much smaller scale, river valleys or flood plains were built up by overflows similar to those of the Mississippi and Nile rivers. But in America we have not yet evolved an agriculture that welcomes annual or even periodic floods as a benefit to the farmer, and all our efforts are devoted to keeping the water off of cultivated lands.

On most of the vast expanse of our fertile plain and rolling upland, a second process took place after the sea retreated. The top soil was built up over thousands of years by the slow accumulation of vegetal remains, humus, bacteria, and amoebae in the soil. This fertile top soil, whether caused by forests, or even more rapidly, by grasses, is the cornerstone of agriculture. Its removal by sheet and gully erosion has practically destroyed more than 21,000,000 acres of land formerly in cultivation, according to the 1932 report of the Secretary of Agriculture.

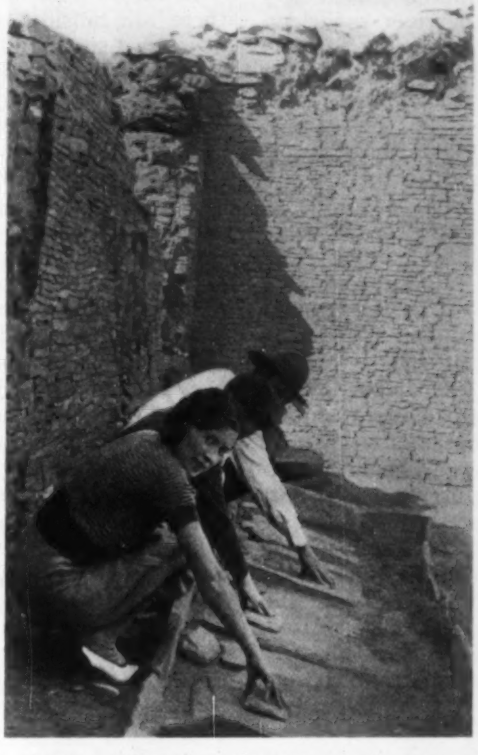
Once this soil is borne away by rapidly moving waters, it will be deposited first at the bottoms of steep slopes in alluvial fans, where are found the larger boulders and coarser material eroded by floods. Next, the finer sediment will be left on overflowed flats; and finally, lakes natural or artificial, including storage reservoirs, will act as settling basins to remove the entire residual load. The streams issuing from the larger reservoirs, such as that formed by the Elephant Butte Dam, are clear. The rate of deposit for that reservoir is given as 0.7 per cent annually, so that a period of approximately 140 years will effect the total depreciation of this structure through obliteration of its storage capacity.

In which of these several processes can benefit be found for the generation now living or its successors? Surely not in the additional picturesqueness of the scenery! The removal of a foot of soil from the hills would not change their contours, but would go far to render the entire country uninhabitable. What happens to this soil a million years from now is of no present interest either to engineers or to the public.

The effect of improper cultivation of soils subject to erosion is no longer a topic on which any difference of opinion can be expressed. An impressive volume of testimony to the existence, extent, and causes of such erosion may be found in the libraries of the Department of Agriculture and state experiment stations, where are recorded the results of research on all phases of this subject by agricultural economists, engineers, and soil-specialists.

There remains a further phase of the subject, as applied to the large areas of grazing lands both on and off the public domain, on which the available evidence is less voluminous, though just as positive in its conclusions. Here, as on much of the original prairies, the cover consists of grass, herbs, or shrubs, dwindling in density as aridity increases, and presenting in consequence all gradations of cover from bare soil to a complete turf. There exist many areas in the West, known as Bad Lands, of which the Grand Canyon of Arizona is an example, where, because of topography, character of soil, and dearth of rainfall, the processes of erosion are unchecked and limited only by the infrequency of the rains. When rains do occur, sometimes at intervals as long as twenty years (the chips from the original wooden bridges of one of the southern transcontinental lines are said to have lain undisturbed for this length of time), they are apt to take the form of cloudbursts, causing excessive erosion. On such areas there is but little in the way of control that can be done to minimize the results of erosion.

However spectacular these Bad Lands may be, they comprise, together with all other barren and inaccessible mountain areas unfit for grazing, not over 11 per cent of the great intermountain region, embracing 184 million acres, where the problem of erosion on public lands is acute. Of this total, another 11 per cent is commercial timber land, and 3 per cent is cultivated, leaving about 75 per cent, or 139 million acres, on which the only natural force that acts to restrain erosion is the vegetative cover that forms the subsistence of the grazing animals. If it can be shown that the destruction of this vegetative cover is the direct source of destructive erosion, then the possibility of an enormous increase in the rate of silting of reservoirs is indicated. Also, if it can be shown that the preservation of the cover would reduce this process to negligible proportions, then the means of control and prevention of the damage is evident.



INTERIOR ROOM OF PUEBLO DEL ARROYO, NAVAJO COUNTY, NEW MEXICO
Used for Grinding Corn

Overgrazing of the open public domain has been the common practice now for several decades. Admittedly, this practice has resulted in widespread reduction in the carrying capacity of the range and often in total destruction of the forage plants, or vegetative cover, on these lands. Has this phenomenon been accompanied by increased erosion, and if so, to what extent?

The site of the well known ruins, Pueblo Bonito, in the Chaco Canyon National Monument, lies in the Navajo country of northwestern New Mexico, east of the Navajo Indian Reservation. Of the country, J. P. Kinney, Chief of the Forestry Branch of the U.S. Indian Service, Department of the Interior, said in the *Journal of Forestry* for December 1932:

> There has been excessive grazing over a part, or all, of the lands for many years. This is particularly true of the Navajo country. It is on these reservations that the greatest difficulties of adjustment and improvement will arise. The Navajos are an industrious and independent race, who are compelled by inexorable circumstances to wrest a living from a land where the forces of nature seem often to conspire against every living thing. For decades the Navajo has secured his main living from sheep and goats, which from early morn till late afternoon the year round, are assiduously engaged in the effort to find sufficient grass or browse to satisfy "the inner craving." Throughout extensive forest areas few young trees can be found that had not reached a height of 4 ft or more before the sheep and goat industry became firmly established; and over large areas there is every evidence of the depletion of the grass cover through excessive grazing.

The opinion of Mr. Kinney was amply borne out by observations I made in the course of a trip through this country during the past summer. Sheep were everywhere in evidence, and in very poor condition. At Chaco Canyon a single Douglas fir tree was seen, about 3 ft high, stunted for years by the browsing of the animals, and bearing green foliage only on the inside of the crown, where the sheep could not reach it on account of the dead outer branches.

In this canyon some 14 separate ruins of communal dwellings, estimated to have contained over 5,000 people, exist within a radius of six miles. When, about 864 A.D. and thereafter, as established by the tree ring calendar of Professor Douglas, these numerous pueblos were built, the inhabitants constructed at least one of these structures, now known as the Pueblo del Arroyo, on the level plain or floor of the canyon some 300 ft from the stream. The first white explorers reported in 1849 that the valley was still intact, and contained a normal stream bed 8 ft wide and 2 ft deep. Erosion of the canyon began in a gradual manner and became more accentuated as the destruction of the sod by grazing progressed, until in 1924 a wash from 200 to 300 ft wide and 30 ft deep was rapidly eating out the heart of the canyon. The ruins of Pueblo del Arroyo, an interior room of which is shown in one of the illustrations, now stand a bare 100 ft from the brink of this chasm.

These pueblo people had neither cattle, sheep, nor horses. In their day, and until recent times, the forces of erosion remained normal in this canyon. Now, with the balance of nature violently disturbed by overgrazing, erosion has moved a thousandfold more soil in fifty years than in the preceding ten centuries. The National Park Service is considering ways and means of checking the destructive process, which, unless stayed, will engulf this ancient ruin in a short time. Preventive measures will require the services of engineers. The extent of the cutting of the wash is shown in another illustration.

That this condition is widespread throughout the arid Southwest has been shown in many published articles. In *Science* for October 16, 1925, Dr. Kirk Bryan listed 21 important streams in Colorado, Utah, New Mexico, and Arizona, and stated that it was evident to all observers that the formation of the channel trenches was recent, as early settlers could remember the time when many of these flood plains were intact and the floods spread widely. At that time, meadows, belts of cottonwood, willow trees, and even swamps characterized the floors of valleys that now support only scattered sage, greasewood, or mesquite. Notable changes in population have occurred, and therefore the cutting of the arroyos is an outstanding event of interest to historians. The dates of the beginning of cutting coincide with those of settlement—from 1880 onward. In the previously mentioned article, Dr. Bryan states:

> Most of the writers who have considered the question attribute the erosion of the arroyos to the introduction of livestock and the consequent decrease in the vegetative cover and the formation of trails. These changes promoted rapid run-off and increased the rate of erosion.

Similar conclusions were reached as early as 1918 by Frank H. Olmsted, M. Am. Soc. C.E., in a report on flood control of the Gila River in Graham County, Ariz., prepared for the Secretary of the Interior and published as Senate Document No. 436 of the 65th Congress, Third Session. Mr. Olmsted said that up to less than a generation ago there were no indications, either on the lower rim or in the mountains, that heavy erosion had taken place. In 1856 the river ran clear. After the flood of 1916, the channel, formerly between 150 and 200 ft wide, had a width of 1,935 ft, and 46 per cent of the agricultural lands of the valley were gone. In his report Mr. Olmsted stated that "The first step in the control of erosion in the Gila River basin lies in regulatory measures where grazing is now heavy." He also emphasized the fact that erosion starts at the very heads of the ravines and that control must begin there.

In the Pike National Forest in Colorado I encountered another example of the effects of upsetting the balance of nature and thus accelerating erosion. This time cultivation of the soil was responsible for the destruction of the sod. The accompanying series of four photographs were taken on Fountain Creek above Manitou, Colo., and illustrate the progressive destruction of farm land due to insufficient natural cover. The first illustrates the natural condition before gullying. The part of the valley shown was then protected by willows along the stream and a heavy sod of alfalfa on the adjoining strips. In the next can be seen the cultivated field lying below this meadow. The willows have been cut and burned, the native sod broken up, and field crops raised. In the third, the junction of the two fields is shown, with a division fence. The alfalfa sod is being slowly undermined by the gully, at the rate of 10 ft for the season of 1932, since the picture was taken. Willows, on the other hand, are very effectual in checking the progress of such a gully.

The first cultivation on this bottom was in 1875, but for a long time the willows were left undisturbed. In the lower part of the valley, however, erosion set in earlier, caused by a combination of factors—cultivation of the narrow strips of fertile soil in the gulch bottoms, grazing and logging on the adjacent slopes, and the development of roads and trails, which served as starting points of the process. In the fourth of the series, the same gully appears at a point one-half mile below the fence. Here the destruction is almost complete; a barn site has been nearly undermined; most of the arable land has been destroyed; and large gashes have been cut into the mountain slopes. The state highway is threatened, and the state highway department has placed tree tops in the bend to check cutting and has straightened the channel above this point to divert the water from the bank. In 1918, the bridge on the main road, lying halfway between the points shown in the third and fourth photographs in the series, was washed out and replaced by a concrete structure. Since that time the channel has continued to cut rapidly deeper and wider.

In the vicinity of Arrowrock Dam, near Boise, Idaho, there are hillsides which within the last decade have developed small gullies that honeycomb their surfaces in a most sinister manner. Overgrazing has been admitted to be the cause of this phenomenon. The Arrowrock Reservoir has already lost 6 per cent of its storage capacity by silting.

In the valley basin of Great Salt Lake, recent erosion has gullied the hills bounding the plain, cutting through ancient lake-shore terraces that had remained undisturbed since the glacial epoch. It was in Utah, in the valleys tributary to the basin of the Great Salt Lake, where the steep slopes of the Wasatch Mountains adjoin fertile and irrigated plains under intensive cultivation, that the earliest and most convincing demonstrations occurred of the close relationship between grazing, erosion, and damage to farm land. As a result, systematic research was undertaken. One study, covering a period of 15 years, has recently been concluded.

On the Wasatch Range, between 1888 and 1905, overgrazing by sheep in competition for free range on the public domain reduced the entire country from Thistle to Salina to a vast dust heap, grazed, trampled, and burned. There had been no serious floods before 1888, but between that year and 1910 bad floods occurred in nine seasons. In 1904, or shortly after, the region was withdrawn as a National Forest, all stock was excluded from Manti Canyon for five years. In 1909, as a result of this protection, the canyon entirely escaped the effect of a severe flood which ravaged Ephriam and Six Mill canyons, situated on each side of the protected area. As a result of this demonstration, two plots in Ephriam Canyon were established by the U.S. Department of Agriculture in 1912 to afford measurements of the influence of vegetation on erosion. A report of these tests was published by the Department in Bulletin 675, of January 25, 1918. The authors of the report stated:

> Before the ranges had been overstocked and the ground cover impaired, erratic run-off and erosion were practically unknown.
>
> Numerous instances are on record where serious erosion was unknown until the ground cover was largely destroyed. On the other hand, in localities where the destroyed vegetation has been reestablished, a few typical cases of which are pointed out in the body of this report, serious erosion has been stopped.

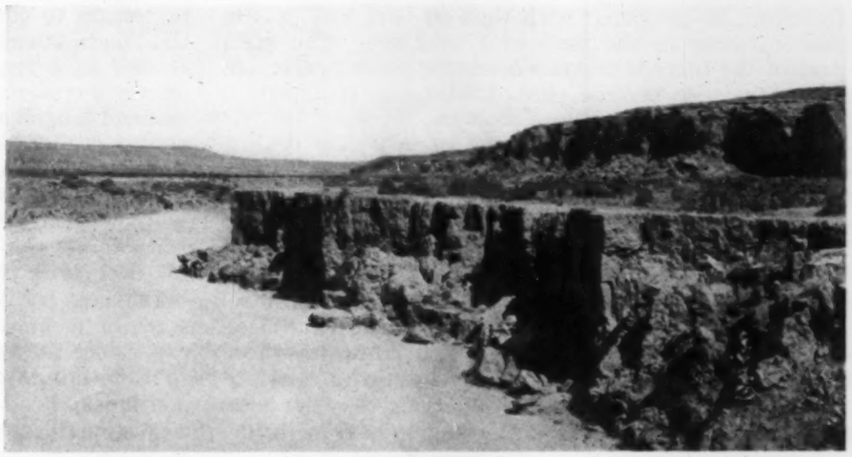
EFFECT OF ACCELERATED EROSION IN FOUNTAIN

(1) In Its Natural Condition Before Gullying; Valley Protected by Willows Along the Stream and a Heavy Sod of Alfalfa on Adjoining Strips

(2) Cultivated Field Below Meadow Shown in Photograph 1; Willows Cut Down, Cover Destroyed by Cultivation, and Erosion Begun

Serious erosion on Western range lands is due chiefly to the destruction of vegetation as a result of overgrazing and mismanagement of livestock.

In 1931, the final report on these two experimental plots appeared in Technical Bulletin 220 of the U.S. Department of Agriculture. Great care had been taken to secure comparable areas on which the conditions could be controlled. One of these plots possessed but 16 per cent of vegetative cover, because of overgrazing. On the other, the cover approximated 40 per cent. The maximum cover possible was considered to be around 60 per cent. For six years these plots were maintained in status quo, while records were taken of run-off and erosion. Then, over a three-year period, the cover on the overgrazed plot, by protection and some seeding, was brought up to 40 per cent so that it was equal to that on the second plot. Another six-year period elapsed. Briefly, the final result was that the increase in density of from 16 to 40 per cent of a complete cover reduced the rainfall surface run-off 64 per cent and the rainfall erosion 54 per cent, although but two-thirds of a possible cover of 60 per cent density had been attained.


DESTRUCTIVE EROSION IN CHACO CANYON, NAVAJO COUNTY, NEW MEXICO
Deep Arroyo, Eroded Since 1874, Within 100 Ft of Pueblo del Arroyo

The processes of erosion did not wait for the completion of these investigations. Overgrazing on the public domain continued. In the summer of 1932, in the section between Ogden and Salt Lake City, over a dozen floods occurred, burying rich farm lands, moving great boulders (one of which weighed 300 tons), sweeping away houses, filling orchards with earth and rocks, and damaging highways alone to the extent of $100,000. Since the glacial period, mud flows and floods of this character had never occurred in this area previous to 1923. These floods originated on the denuded upper limits of the slopes, in gullies, which opened up where heavy overgrazing by sheep and cattle had removed most of the plant cover. It was known that these areas had been denuded very recently, since there still remained a few scattered plants of species that require rich soil for their existence. This soil had been completely eroded away at that time.

The testimony of Professor Reed W. Bailey, before a Senate committee in May 1932, offers evidence of the severity of these floods on a basis conforming to engineering standards of accuracy. His method of measurement does not require the slow and expensive process of gathering comparable data from controlled plots. He measured the cubic yardage of the deposits in the alluvial fans formed by the floods from 1923 to the present time and compared it with the cubic yardage deposited between 1923 and the recession of Lake Bonneville in geologic time. His summary was:

> From the foregoing study it is concluded that the 1923 and 1930 floods mark a radical departure from the normal post-Bonneville erosion and sedimentation. In depth of cutting, in quantity of material and size of boulders carried, these floods exceed any others that have taken place since the recession of Lake Bonneville. The alluvial deposits made since Lake Bonneville's time are small, and the quantity of material brought from the canyons and added to them by the recent floods is all out of proportion to the amount brought down through the thousands of years of post-Bonneville history.
>
> The conditions producing this accelerated erosion are found on the watersheds. The three most important factors contributing to the floods are topography, rainfall, and locally depleted vegetation.

Many other articles and publications testify to the widespread and convincing character of the evidence as to the origin and causes, and the results of erosion. A report to the California Legislature of 1921, on Senate Concurrent Resolution 27 by the California State Board of Forestry, by E. N. Munns, contains a bibliography of 59 publications on erosion alone. The scientific findings on the subject are well summed up by E. I. Kotok in the September 1932 issue of *American Forests.* He refers to the research of the forest experiment stations and

CREEK CANYON, ABOVE MANITOU, COLO.

(3) Boundary Fence Between Fields Shown in Photograph 2; Cutting Somewhat Retarded by Alfalfa Roots but Proceeding Slowly in the Absence of Willows

(4) A Half Mile Below Field Shown in Photographs 2 and 3, Where Gully Is 100 Ft Wide; Farm Land Destroyed, and Farm and Highway Threatened

especially that of W. C. Lowdermilk, who, after an unusual opportunity to observe at first hand the causes and effects of erosion on the Yellow River watershed in China, was given this problem to study in California. He found that on soil covered by forest litter the amount of erosion, as compared with that on bare soil, was in some instances in the ratio of 1 to 2,300. The main effect of the litter is to keep open the pores of the soil, which otherwise become choked with fine sediment so that the precipitation cannot soak in.

To a biologist, or to any scientist or worker dealing with natural or living forces, the idea that there exists a delicate balance between the destructive forces of erosion and the constructive forces of soil building is readily acceptable. In extreme cases, as on the Bad Lands, this balance does not exist, but over practically 90 per cent of our Western public domain it does or did control erosion to the extent of rendering it practically harmless. Within the last few decades this balance has been destroyed over vast areas by the advent of white civilization. The only operative cause affecting the huge nonforested area of the intermountain region is overgrazing. Left unchecked, this accelerated erosion is capable of filling all storage reservoirs, making irrigation impossible, destroying or burying large areas of farm land, reducing the capacity of the ranges to one-tenth of their former value by removal of the fertile top soil, and in all these ways diminishing appreciably the capacity of the region to support population.

These facts are now commonly accepted in whole or in part by the citizens of this intermountain region. In the light of them, would it not be well for the engineering profession to combine the method of protracted scientific fact-gathering with that of extensive or general studies as a means of reaching conclusions as to the causes of erosion and means of its control, rather than to suspend judgment for additional decades on the plea that erosion is a fundamental process of land sculpture, which, even from a local and temporary outlook, may possibly exert an influence beneficial to human activities?

Engineering works—levees, storage dams, diversion or wing dams, settling basins, check dams, and structures for deepening channels, preventing bank cutting, and harnessing torrents—all have been brought to a high state of technical perfection. From many decades of experience the French and Chinese engineers know what to do to minimize the damage from floods. Yet erosion continues, floods occur, the Yellow River bursts its banks, and reservoirs become filled with silt. Why? Because engineering works alone will never restore or overcome the widespread destruction of the natural tension between erosion and soil building. There is not room enough in all the rivers for the soil whose place is on the hills. Control of soil demands control of grazing.

U.S. Bureau of Reclamation

LAGUNA DIVERSION DAM ON LOWER COLORADO RIVER, YUMA PROJECT, ARIZ.

Great Quantities of Silt, More Than Enough to Cover a 640-Acre Farm 200 Ft Deep, Are Carried Annually to the Lower Delta. Of the River in Flood, Elwood Mead, M. Am. Soc. C.E., Has Said, "It Is Too Thick to Drink and Too Thin to Plow."

Separating Grades at Highway Intersections

Experience to Date Emphasizes Advantages to Be Gained and Pitfalls to Be Avoided

By Herbert S. Swan
City Planner, New York, N.Y.

BOULEVARDS, so popular a generation ago as the ideal of sumptuous highway travel, have been superseded in modern terminology by "parkways" and "superhighways." But whatever the name, the purpose remains the same—to promote comfort, speed, and safety in vehicular transportation. These aims as applied to high-speed automobiles often involve grade separations. As shown in this paper, a wide variety of arrangements for ramps, underpasses, and turns have been worked out. Using actual examples to illustrate his points, Mr. Swan indicates the relative utility of all possible arrangements and some of their limitations, as well as possible future developments. With the growing popularity of highway-crossing elimination, these principles seem likely to receive increasing attention.

SEPARATION of grades at cross streets has been hailed almost universally as a solution of the difficult traffic problems that develop at congested intersections in that it obviates the alternate starting and stopping of the through traffic. In other words, it tends to bring the actual traffic capacity of each street up to its potential unobstructed capacity. The practical effect, in a particular case, may be equivalent either to the doubling of the existing street width or to the opening of an entirely new street.

Doubtless such a separation of grades on a main highway, particularly at cross streets carrying a heavy volume of traffic, is decidedly convenient for the straight traffic on both streets. Typical examples designed and built by the New Jersey Highway Commission are shown in Figs. 1, 2, and 3. At the normal intersection, probably not more than 10 or 20 per cent of the total is turning traffic, assuming that the street plan in the vicinity is fairly well designed to care for the normal traffic movements of the community. Obviously, if there is a proper separation of grades, from 80 to 90 per cent of the traffic will be relieved from practically all interference from crossing or conflicting streams, that is, if the separation is properly designed, which most separations are not.

SEPARATIONS MULTIPLY TURNS

Few people have ever stopped to consider the effect of separating grades on traffic. The general impression seems to be that any separation will remove all obstructions to movement at an intersection—not only those due to cross traffic but also those due to left turns. In many instances nothing could be further from the truth, for very few separations have actually eliminated all the interference between conflicting traffic streams.

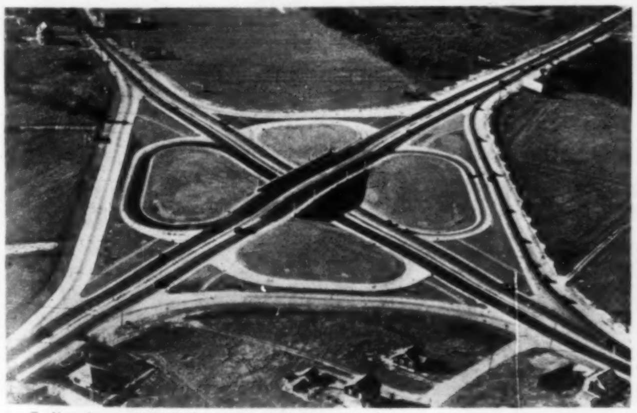
At a simple intersection of two streets there are 12 possible directions open to traffic: it may go straight in both directions on either street or it may turn either right or left into its appropriate cross street. And each of these movements—straight through, right turn, and left turn—may be made for four directions of traffic. A separation of grades, as such, merely furnishes an unobstructed path to the four streams of straight traffic. Interchange between the two streets is left entirely to connecting ramps.

There may be instances, as on the Long Island Motor Parkway, where there are no ramps at all, the sole consideration being separation for straight traffic. This is probably because it is a through toll road. But such instances are rare.

Paradoxical as it may seem, every grade separation has the effect of doubling the number of turns that the interchanging traffic at a simple intersection must make. At such an intersection of two streets at grade, there are four right and four left turns that may be made—eight all together. But at every intersection where the grades have been separated there are always 16 turns. The number of right and left turns will differ according to the number of ramps provided, but the sum will always equal 16.

TRAFFIC DEMAND GOVERNS RAMP TYPE

There are 15 different possible arrangements of ramps at a simple intersection. In the light of the various possible combinations, it is obvious that the collection of a considerable amount of data showing the character, distribution, and volume of traffic should precede any defi-



© New Jersey State Highway Commission

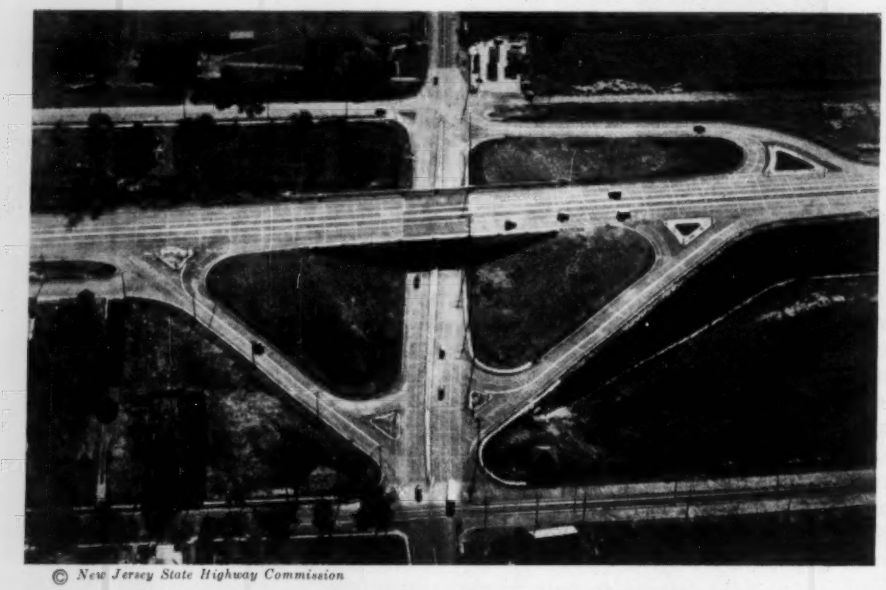
Four-Leaf Clover Intersection at Woodbridge, N.J.
Blackness of Pavement Indicates Relative Volumes of Traffic

© Westchester County Park Commission

Narrow Connecting Ramp with Sharp Turns
Bronx River Parkway and Palmer Avenue, Bronxville, N.Y.

nite decision as to the arrangement and number of ramps to be built at a particular intersection.

As far as interchanging traffic is concerned, even the simplest type of separation—that having but a single ramp—always produces eight left turns and eight right turns. As a result, the straight traffic on both streets suffers twice as much interference from turns as it would were both streets on the same grade.



© *New Jersey State Highway Commission*

GRAND AVENUE, ENGLEWOOD, N.J., PASSING UNDER ROUTE 4

If two ramps are used, there will still be four left-hand turns for the interchange of traffic. It does not matter how the ramps are arranged, whether they are on the same or on opposite sides of either or both streets, the number of such left turns will be the same. If the ramps are on opposite sides of the main thoroughfare, but on the same side of the cross street, all four of the left turns will occur on the minor street. But should the two ramps be located diagonally opposite each other, the left turns will be divided between the two streets.

Triple ramps have the effect of reducing the necessary number of left turns to two. But the number of right turns is increased from 12 to 14. Not unless four ramps are constructed, as was done at Paramus and Teaneck, N.J., (Figs. 4 and 5), is it possible to eliminate all the left turns. But in this case two right turns must be introduced for every left turn eliminated. Every vehicle desiring to make a left turn must first pass over or under the cross street, then turn to the right in the opposite direction to which it wishes to go, and finally, when it reaches the cross street, make another turn to the right. This unnatural routing is undoubtedly somewhat bewildering to a large number of motorists and requires a generous use of directional signs. In Figs. 6, 7, and 8 are shown solutions used by the New Jersey Highway Commission for some of its more complicated problems of this nature.

DETERMINING DIMENSIONS OF RAMPS

Ramps connecting two cross thoroughfares at different levels, if sufficiently wide and long, are in themselves a sort of reservoir space for turning traffic. If they are too narrow, they may cause traffic to back up and thus congest the main roadway. A similar situation may develop, of course, where the turning radii of the ramps are so short as to hamper free flow.

Some intersections find their primary function, not in serving cross traffic, but in providing an interchange of turning traffic. In many such instances, there is little doubt but that a traffic circle would be superior to a grade separation. Take, for instance, two cross streets where there is a particularly heavy volume of turning traffic. Conceivably, the turns may involve such a volume as to render the connecting ramps practically impotent for purposes of interchange. Although no case is known where this has occurred, it might be necessary to install stop-and-go controls on both streets. A football game, or almost any event that attracts huge crowds, may entirely upset for a few hours the smooth operation of even the most carefully planned grade separation, particularly where there are less than four connecting ramps.

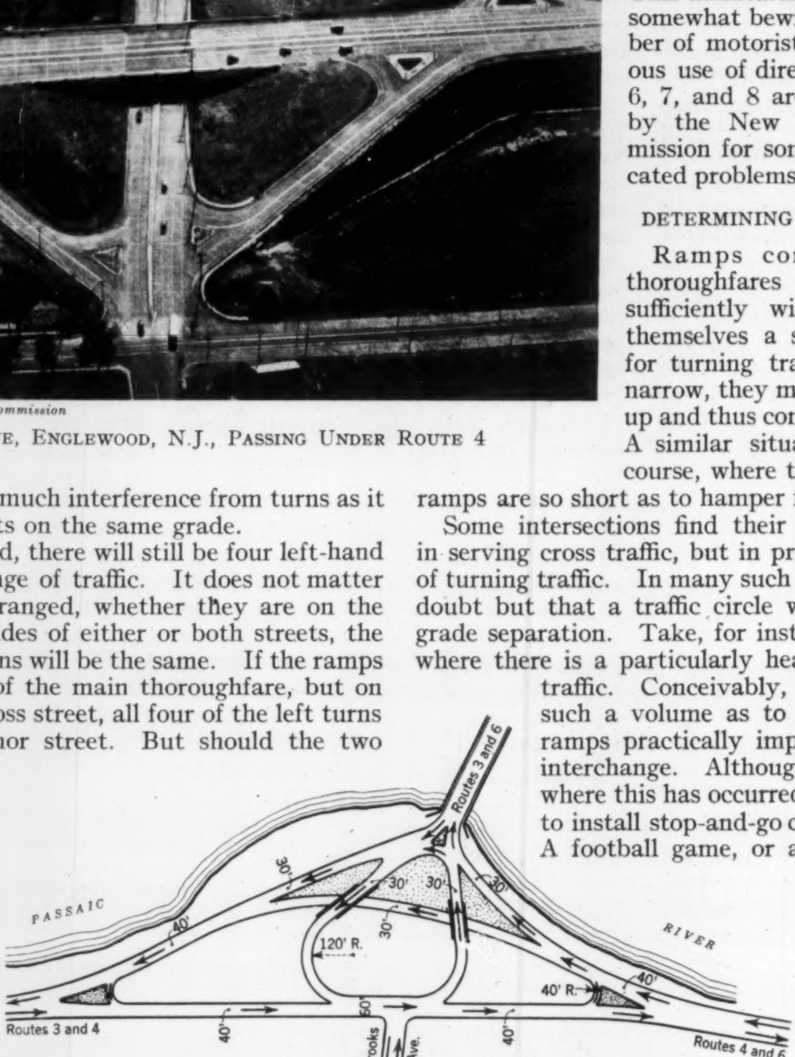


Fig. 1. At Paterson Junction

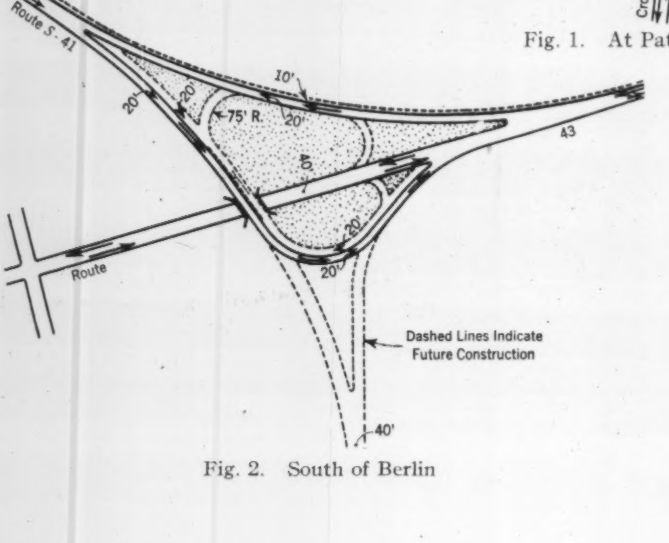


Fig. 2. South of Berlin

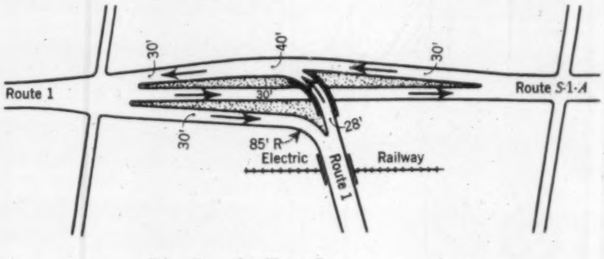


Fig. 3. At Fort Lee

TYPICAL HIGHWAY GRADE SEPARATIONS ON THE NEW JERSEY STATE HIGHWAY SYSTEM

Even the provision of four ramps will not necessarily obviate all left turns. On the Grand Boulevard and Concourse in the Bronx, New York City, at Fordham Road, the central section of the concourse dips under the cross street while the two service roads on the side continue at their original grade. The through traffic on the Concourse flows continuously in the underpass oblivious to all traffic lights or other interference. Not so, however, the traffic on Fordham Road. There almost as much time is allowed for the four sets of left turns to and from the Concourse and for pedestrians along the Concourse as for the straight traffic.

CENTRAL RAMPS CAUSE HAZARDS

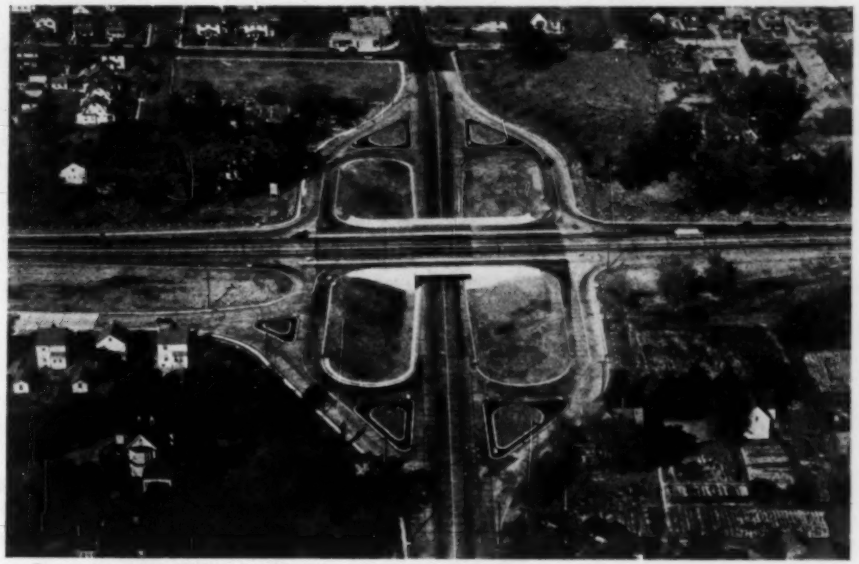
On the superhighway approaching the Holland Vehicular Tunnels, through Newark, N.J., as on the new elevated highway on West Street, Manhattan, central ramps are utilized to facilitate interchange of traffic, the highway being splayed so that through vehicles can go around the ramp on each side. This creates a distinct hazard in obliging fast traffic to swerve out of its course in passing by the mouth of these ramps. Side ramps would appear to be much safer.

Central ramps, and side ramps too, if they are crowded up close to the elevated street, are objectionable in their effect on traffic on the cross street, since they require left turns in leaving or entering the ramps, the same as if there were no separation of grades.

Where the volume of turns from the superhighway is considerable, such traffic, because of congested conditions on the cross street, may be unable to get away freely and will therefore back up traffic on the superhighway. The only justification for such ramps is, of course, the practical one that a more ideal arrangement would necessitate the use of too large an area of expensive land.

FOUR-LEAF CLOVER CONNECTIONS

There are various kinds of separations known popularly, on account of their quadruple and symmetrical connections, as "four-leaf clovers." Some, like those illustrated at Woodbridge (see photograph) and Paramus (Fig. 4), provide eight separate roadways for right and left turns of interchanging traffic, while in others, as at Teaneck (Fig. 9) both the left and right turns utilize a common roadway. It may be asked, what are the respective advantages of these two types? The former, which separates two kinds of turns, undoubtedly makes for greater safety in that there can be no head-on collisions. In all probability this type will also care for a larger volume of turning traffic. Even though a tremendous amount of traffic may desire to turn to one side, that to the other side will still be able to continue without obstruction. With a common roadway, however, the two movements may so interfere with each other as to prevent an effective interchange. This is apt to be true particularly if the ramps are narrow or but one or two in number.



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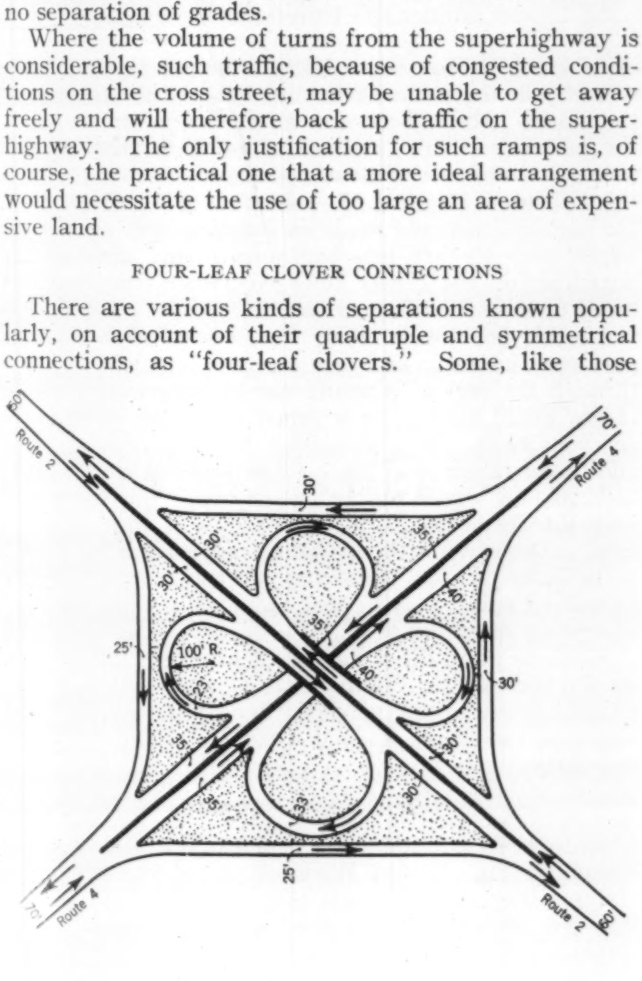
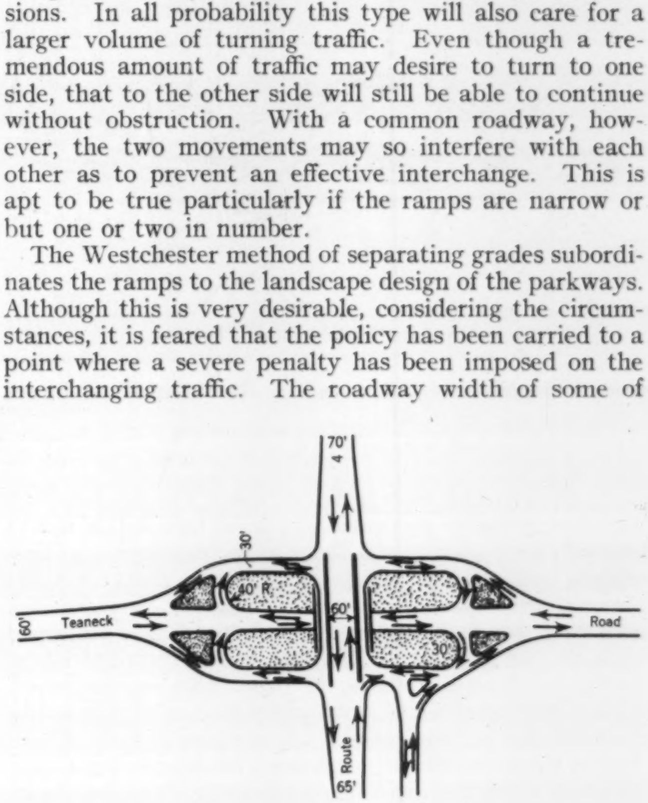
Teaneck Road Passing Under Route 4, New Jersey

Four Connecting Ramps Shown in Fig. 5

The Westchester method of separating grades subordinates the ramps to the landscape design of the parkways. Although this is very desirable, considering the circumstances, it is feared that the policy has been carried to a point where a severe penalty has been imposed on the interchanging traffic. The roadway width of some of





New Jersey Grade Separations with Four Connecting Ramps

Fig. 4. (At Left) Four-Leaf Clover Design at Paramus

Fig. 5. (Above) Connecting Ramps at Teaneck these ramps is about as narrow, considering the sharpness of the turns used, as could possibly be utilized by two streams of passing traffic. The State Highway Commission in New Jersey has in this respect been far more generous in its treatment of turning traffic, for it has provided not only more ramps, but ramps of larger radii and greater widths.

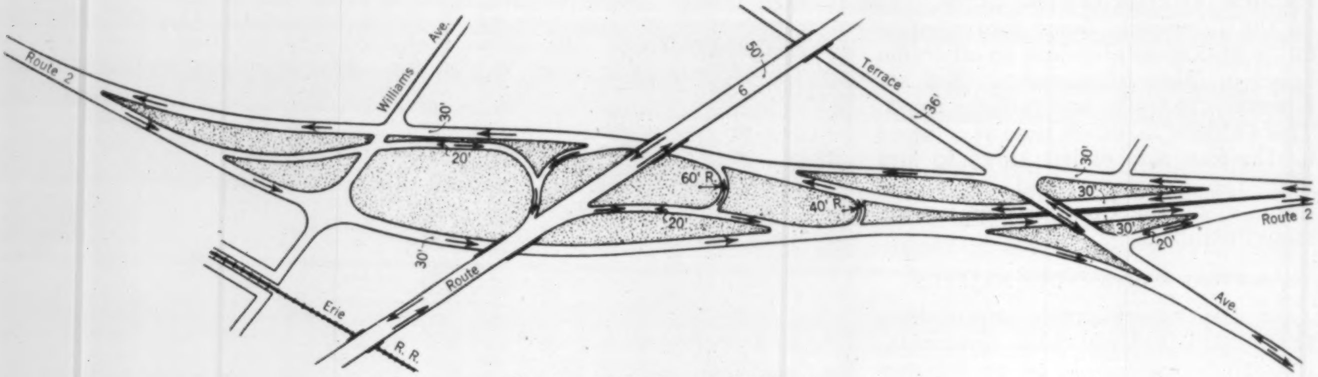


Fig. 6. At Hasbrouck Heights

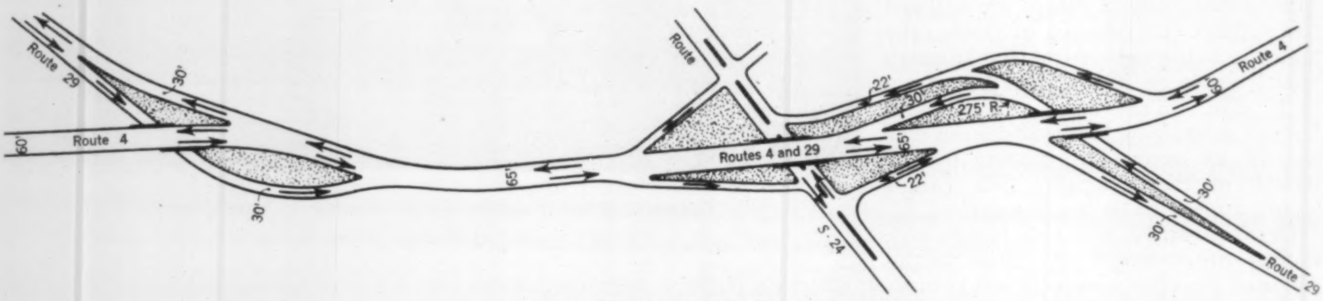


Fig. 7. In the Town of Union

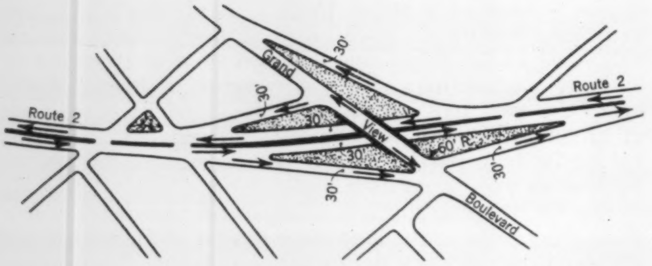


Fig. 8. In the City of Hackensack

CONFUSING SEPARATIONS IN NEW JERSEY WHERE DIRECTIONAL SIGNS AND BUILT-IN REGULATION AID TRAFFIC

TWO ACCESS DRIVES SUFFICIENT IN WESTCHESTER

On all recent projects in Westchester, the aim has been wherever possible to provide at least two access drives between the parkway and the intersecting street. These usually join the parkway on opposite sides and are planned with the idea of eliminating left turns on the parkway, where a higher rate of speed is maintained than on the highways. No instance is recorded where traffic has been held back on either parkway or street. Under the conditions now prevailing in Westchester County, it is unnecessary to construct four access drives, since no difficulty has been experienced with left turns on the highways. In the county there are, however, many grade separations with only one access drive, necessitating left turns on the parkway itself. The intersecting street is a secondary one and the amount of traffic that must necessarily make a left turn on the parkway is not sufficient, at present at least, to justify the expense of a second access.

Most of the access drives are sufficiently long to accommodate a large number of cars waiting to move into the stream of traffic on the intersecting street, but so far no instance has been experienced where this line extended back into the parkway. Wherever the access drives are on a grade, it has been deemed important that they should join the parkway not in, but at the bottom of, the grade. All traffic makes a full stop before entering the parkway. This is also true of traffic leaving the access drive to enter the intersecting highway. Because this full stop is required, the radius of the corner entering the parkway has been made only sufficient to enable the largest cars to turn into the outside lane without encroaching on the center lanes even when traveling at a speed of 15 or 20 miles per hr.

As the population along the Westchester County parkways increases and new currents of traffic develop through the region, it would not be surprising if some ramps would have to be widened as well as given more generous radii. It is altogether likely, moreover, that additional ramps may have to be built at those intersections now served by but one or two. The trend will undoubtedly be to provide four ramps at each intersection; otherwise, with conditions approximating maximum traffic on cross street and parkway, congestion due to turning traffic may be just as bad as if there were no separation of grades at all.

All these possibilities have evidently been anticipated by the Westchester County Park Commission, as it has already provided the necessary land required for additional access drives, as and when they shall be found necessary.

SOME POSSIBLE SAVINGS

In New Jersey, some four-leaf clovers, like those at Paramus (Fig. 4) and Woodbridge, or at Hasbrouck Heights (Fig. 6) and Union (Fig. 7), occupy an area of between 20 and 25 acres of ground. Simple grade

101st Street Passing Under the Concourse

Fordham Road Passing Over the Concourse

Grade Separations on the Grand Boulevard and Concourse, Borough of the Bronx, New York, N.Y.

separations, however, with common roadways for left- and right-hand turns have required only five acres, such as at Teaneck (Fig. 9). This fact alone does not indicate the superiority of the simpler type; in some instances it would be entirely incapable of caring for the heavy volume of traffic, and particularly turning traffic, that might utilize the more complicated type of crossing with ease. The latter, however, costs so much to construct and requires so much land that it is absolutely out of the question in built-up areas.

Indications are that at Woodbridge a smaller number of ramps, probably six, would have been adequate. Traffic counts show that there is little traffic between Rahway and New York, and Woodbridge and Trenton. A single consolidated ramp for these right and left movements would probably have proved sufficient.

An alternate arrangement to accommodate a large volume of turning traffic is the provision of increased width in the main roadway to serve as reservoir space for turning movements, both before and after completing the turn, so as not to retard the movement of straight traffic on either of the two cross streets. This facilitates particularly the infiltration of traffic turning out of, and into, the main stream of through traffic before and after leaving the ramp. Strange to say, this arrangement has not been generally used in grade separations; the only instance that has come to my attention is on the Mount Vernon Memorial Highway, where two roadways under a bridge were each given a width of 40 ft—the same as that of the two merged roadways beyond the intersection.

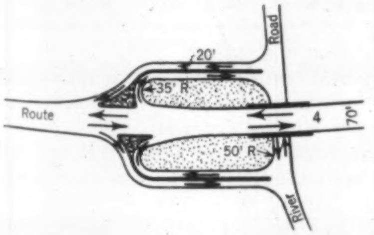


Fig. 9. Separation at River Road, Teaneck, N.J., Utilizes Common Roadway for Connecting Ramps

GRADE SEPARATIONS ON CITY STREETS

On ordinary city streets it is exceedingly difficult, if not impossible, to secure separations that are in all respects satisfactory. Such eliminations, if properly arranged throughout the whole length of a street, may accelerate the movement of the principal stream of straight traffic. But the elimination in such a case would require ramps parallel to the roadway of the principal street. Otherwise, as already pointed out in the case of the Grand Concourse, the benefit that might result from the separation is largely lost as far as the traffic on the principal street is concerned.

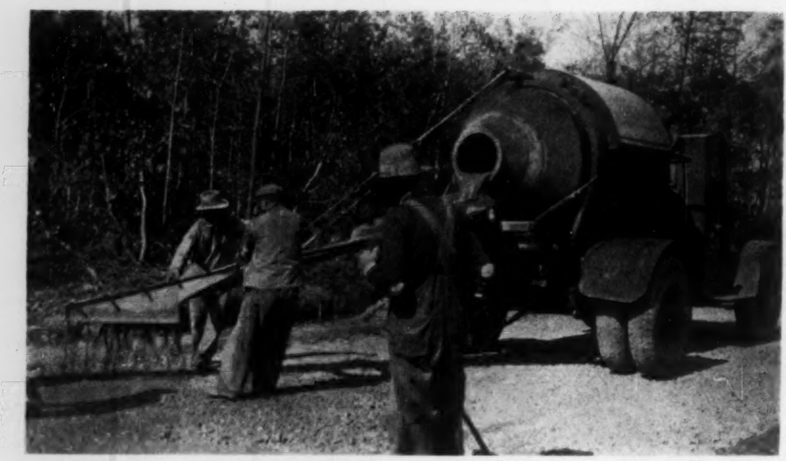
Occasional and isolated grade separations on a highway may of course result in considerable improvement in the general traffic conditions at the intersection. This is particularly true at a critical intersection where the cross traffic is of considerable volume and the neighboring intersections on each side are at some distance. But the value of such a separation is largely lost where nearby streets are permitted to cross at grade. Stop-and-go control at these streets may to a large extent nullify such advantages as may be obtained by grade separation at the principal cross street.

PROS AND CONS SUMMARIZED

Although engineers' experience with the separation of street grades is not of very long duration, it may yet be permissible to draw certain conclusions from it, as follows:

1. The principal advantage of a grade separation is in the accelerated movement of straight traffic through the intersection.
2. The efficiency of a grade separation, in so far as turning traffic is concerned, is determined by the number, length, width, and radii of the ramps or access drives provided for the interchange of traffic.
3. The ramps or access drives, if insufficient in number to eliminate all left-hand movements at an intersection, should be so arranged as to favor the traffic on the principal thoroughfare; in other words, wherever possible all left turns should be shifted off of the principal street on to the minor street.
4. A grade separation that provides but a single access drive for the interchange of traffic may, by increasing the number of turning movements, prove more obstructive to traffic than an ordinary intersection at grade.
5. In width, length, and turning radii, ramps or access drives should be large enough readily to care for all turning traffic.
6. A grade separation may be used advantageously as an auxiliary to a traffic circle by eliminating large volumes of straight through traffic from the rotary roadway used by the turning traffic. The converse is also true; a traffic circle may sometimes prove its worth by complementing a grade separation in performing the functions of interchange, the burden of which otherwise is thrown on the ramps.

Even at best, a grade separation is expensive to construct. As compared with a traffic circle, a "clover leaf" has the advantage that there are no lanes of traffic which cross each other and that there is no slowing up of the straight traffic, which moves along at its usual speed with perfect safety. But any separation less effective than the clover leaf may readily prove as troublesome to traffic as a grade crossing, if not more so. This is due to the fact that a separation with inadequate ramps exaggerates the embarrassing features of turning traffic and multiplies the number of left-hand movements across the paths of the straight traffic.



Special Grout Distributor, Providing Vertical Flow on to the Surface Without Disturbing the Stone

Cement-Bound
for Road

Pennsylvania Highway Department Con-

By C. H. Buckius,

District Engineer, Pennsylvania De-

In an effort to connect the rural highway net of Pennsylvania with the main traffic arteries of the state and to improve the secondary roads with a satisfactory type of low-cost pavement, the State Department of Highways has recently completed a test road of cement-bound macadam. It was believed that the experience gained in the construction of this road

Stone Spreader in Use

The policy of the present administration of the Pennsylvania State Department of Highways, under the direction of Governor Gifford Pinchot and Secretary of Highways, Samuel S. Lewis, has been to recognize the urgent necessity of constructing the rural highways connecting with the primary state highway system so that economic transportation and all the resulting benefits may be furnished to a very large number of the people of the commonwealth who have been neglected in the past as far as improved highways are concerned.

Types and methods of low-cost construction have been studied very assiduously by the engineers of the department, not only of roads in Pennsylvania but in adjoining commonwealths. As a result of these studies of proposed types, the Secretary of Highways authorized the construction of a one-mile section of cement-bound macadam pavement in Northampton County, on State Highway Traffic Route No. 182, between Bath and Moorestown. This section was decided upon because when the entire road is completed it will form a connecting link between Allentown and Bethlehem on the south, and Stroudsburg and Scranton on the north, and will probably carry fairly heavy traffic.

This type of pavement is similar to the "Hassam" pavement, numerous sections of which have been in use in the New England states for many years. These older pavements, most of which are 6 in. in depth, have successfully carried a traffic very much in excess of their original designed capacity.

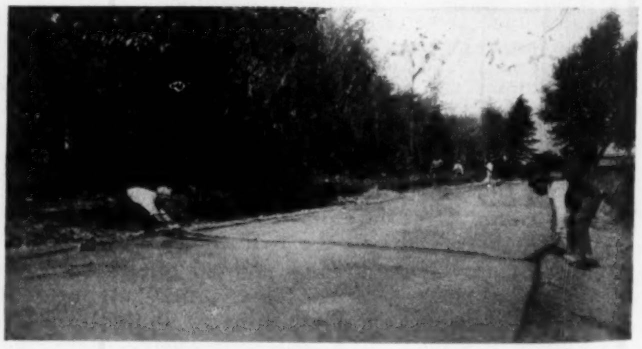
CONSTRUCTION METHODS SIMPLIFIED

In proceeding with this experimental construction it was the purpose of the State Highway Department to place it, as far as possible, in competition with penetration macadam and bituminous surface-treated macadam construction. In construction of the latter kind, where the line and grade of the old road are followed closely, surveys and plans have not been prepared and the new alignment and profile have been developed during construction by experienced foremen, using the "eye-and-string" method, under engineering control and supervision. This experimental section of cement-bound macadam was laid out in the same manner. The curvature was very light, and with the exception of two 5 or 6 per cent hills, the grades were not over 2 per cent.

Rough grading, which consisted of widening the existing highway, smoothing the existing profile, and securing sufficient material for the formation of shoulders, was performed with a ten-ton tractor and a drawn grader. Approximately 4,000 cu yd of material were handled. Fine grading, which consisted of preparing a trough to receive the stone, was performed with a power grader, equipped with a blade and operated on pneumatic tires. The cost of this operation was included with that of the rough grading. The fine grading included the shaping and compaction of the shoulders so as to preclude the necessity of using forms to establish the line and grade of the completed pavement.

Dummy joints for purposes of crack control consisted of 1 by 2-in. wooden strips fastened to the subgrade with 60 d nails. These strips were placed longitudinally on the center line and transversely at intervals of from 200 to 250 ft, as well as at the beginning and end of horizontal and vertical curves.

In the trough cut into the subgrade, $1^{1}/_{4}$ to $2^{3}/_{4}$-in. crushed limestone was spread to a loose depth of $7^{1}/_{2}$ in. for a distance of one-half mile in advance of grouting. Two stone-spreading boxes working practically abreast on the subgrade placed the stone. Although the specifi-



Wet Burlap Belt Used with Saw-Like Motion to Remove Excess Water and Mortar and Smooth the Riding Surface

Macadam Construction

structs a *Mile of Test Road at Bath, Pa.*

M. Am. Soc. C.E.

partment of Highways, Allentown, Pa.

Completed Pavement, the Riding Qualities of Which Have Been Favorably Commented Upon

would be of value to other highway engineers and officials and therefore Mr. Buckius was asked to prepare this article. In it he gives a description of construction methods and a statement of the costs, together with observations on possible improvements in the technic of placing the crushed stone and binding it together with cement-mortar grout.

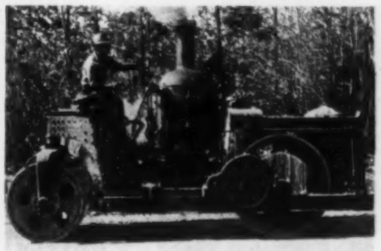
cations allowed 15 per cent of the stone to pass a $1^1/_4$-in. screen, an effort was made to reduce this amount to a minimum. An average of ten trucks, hauling from four to five tons per load, spread an average of 305 tons (588 lin ft) per day. An average of 734 lin ft was covered on four out of the nine days required for the work. By thoroughly rolling the stone with a ten-ton three-wheel gas roller, a compaction of approximately 20 per cent of the loose depth was obtained.

MIXING AND PLACING THE GROUT

Grout material, sand and cement, was batched into "transit-mixed" trucks at a railroad siding at an average hauling distance of $1^1/_4$ miles from the job. A mixer truck held approximately 2 cu yd of grout when 140 to 160 gal of water were added at a point on the job. These trucks, mixing in transit, traveled over the rolled stone to the point of grouting.

By rotating the drum and elevating the front end of the truck mixers, the grout was discharged down a chute and through a special grout distributor, vertically, on to the rolled stone surface, where it penetrated the voids or was swept into them. As shown in one of the photographs, a special grout distributor constructed as a result of experience on work in Morris County, New Jersey, was utilized.

Transverse Construction Joint, End of Day's Work
Pavement Slab Measures 6 In. in Thickness



Rolling the Grouted Surface

After grouting, the road surface was rolled immediately with an 8-ton tandem steam roller. Additional grout, occasionally required to fill voids after rolling, was spread from mixer trucks as before, and the rolling was continued at intervals until an even, completely grouted surface was secured. The surface was then tested with a 16-ft. straight-edge. Depressions were filled with $^5/_8$-in. stone from piles placed along shoulders, or, where required, stone of the same size as that used in the pavement was used. This was also secured from piles on the shoulders. The surface was then given a final rolling. All rolling was completed in $1^1/_2$ hr after the grout was placed.

Projecting stones and other irregularities were smoothed down with a long-handled wooden float. At the proper time, determined by working conditions, the surface was smoothed, and excess mortar and water were removed by working several strips of wet burlap, folded to form a belt, across the pavement with a sawing motion. Because of the high earth shoulders, the pavement usually worked up at the edges. At this stage of operations any raised edges were tamped down by hand. A wide single strip of wet burlap was then dragged forward over the surface as a finishing operation. Only the minimum amount of mortar remained on top of the finished pavement. The surface smoothness obtained was such that there were few irregularities greater than $^1/_2$ in. under a 16-ft straight edge.

As soon as the surface had hardened sufficiently to prevent marring, it was covered with strips of wet burlap and was kept wet, by a hose from a pipe line, for a period of 48 hr, after which the burlap covering was moved ahead. The pavement was used by light local traffic within one week and was opened to through traffic in ten days after the last of the grout was placed.

Grading for this project was completed in September, and the spreading of stone started on October 4. Stone was placed for 4 days ($^1/_2$ mile) in advance of grouting. Grouting operations began on October 10 and were completed on October 19. Shoulder trimming was completed about October 26 and the pavement opened to through traffic on October 29.

A detailed presentation of costs, quantities involved, and other pertinent construction data are given in Tables I, II, III, IV, V, and VI.

Cores removed from the completed road on October 28, 1932, proved conclusively that maximum penetration was not secured, due to the fine particles of stone which filtered through to the subgrade and to a certain amount of stone that was forced into the subgrade during the rolling operation. The results of the examination of these cores are given in Table VI.

TABLE I. SUMMARY OF CONSTRUCTION DATA

Dimensions: length, 5,290 ft; width, 18 ft; thickness, 6 in. uniform; rise at crown, $1^1/_2$ in.
Depth of spread stone: $7^1/_2$ in. loose
Normal mortar mix: 1:2 with from 7 to 8 gal of water per sack of cement
Proportions of mix, by volume: 1:2:11
Quantities of materials used: cement, 1,333 bbl; sand, 572 tons; limestone, 2,750 tons. (This checked with the loose depth of $7^1/_2$ in.)
Additional limestone stored on shoulders and used to correct surface irregularities after grouting: 15 to 20 tons of $^5/_8$-in. size
Cement factor: 1 sack per lin ft of pavement, equivalent to $^1/_2$ sack per sq yd and 3 sacks per cu yd
Total cost, including grading, drainage, and pavement: $13,578.26
Total cost of pavement only: $10,079.95
Total cost of pavement, per square yard: 95.3¢
Data on trucking:
  Number of trucks used: 9 to 11
  Average number of trips made per day per truck: 8
  Amount carried per trip: 4 to 5 tons
  Average day's run: 305 tons, or 588 lin ft of pavement
  Best day's run: 484 tons, or 933 lin ft
  Average haul from the quarry: 12 miles

Below the grout penetration line, as determined by the measurements of the cores removed, the stone was packed very firmly and could be removed only by using a bar. There were evidences of grout in this mixture of fine stone, and it appeared that enough support would be secured from this stone so that the slab itself would not be weakened to any material extent.

Eliminating the few cores of excessively shallow penetration that were removed from sections where it was known definitely that pockets of fine stone existed, the average penetration for the entire project was between 4 and 5 in., and the best average penetration could not be considered greater than 5 in. It is therefore apparent that approximately 20 per cent less sand and cement were used in this entire project than would be required to penetrate the full depth of stone. Adding 20 per cent of the 536 cu yd of grout used, or 107 cu yd, to that actually poured would make a total of 643 cu yd that should have been used to secure maximum penetration. To compensate for the stone forced into the subgrade, 10 per cent more stone than that theoretically required should be provided.

TABLE II. DISTRIBUTION OF PAVEMENT COSTS

	LABOR		EQUIPMENT		MATERIALS	
ITEM	Total	Per Sq Yd	Total	Per Sq Yd	Total	Per Sq Yd
Plant . . .	$446.40	4.2¢	$ 154.71	1.5¢	.....	..
Water supply	219.85	2.1	196.00	1.9	.....	..
Stone . . .	316.55	3.0	183.60	1.7	.....	..
Grout . . .	574.80	5.4	1,317.10	12.5	.....	..
Cement* . .	.....	..	.....	..	$2,066.15	19.5¢
Sand† . . .	.....	..	.....	..	807.14	7.6
Stone ‡ . . .	.....	..	.....	..	3,657.50	34.6
Joints . . .	.....	..	.....	..	140.15	1.3
Total . .	$1,557.60	14.7¢	$1,851.41	17.6¢	$6,670.94	63.0¢

* Net cost f.o.b. Chapman Quarries siding, $1.55 per bbl.
† F.o.b. Chapman Quarries siding, $1.41 per ton.
‡ Delivered on the road, $1.33 per ton.

The correctness of these adjusted amounts is borne out by the results secured on October 12 and 13, from Station 87 + 82 to Station 76+32. According to Table V, these sections of the job were the most normal in that the grading of the stone was the most satisfactory and there was a minimum amount of rolling and trucking due to location.

SUBGRADE READY FOR CRUSHED STONE
Shoulders Cut Vertical; 1 by 2-In. Wooden Joint Strip in Place; Leveling-up Stone Stored on Shoulders; Fine Subgrade Condition

It is felt that the additional quantities of stone and grout could be placed without additional expense, except the cost of the materials themselves, as is shown by the increased speed with which the grouting was done in the last three days as compared with the first four. The probable cost of this pavement, allowing for the addition of these materials, is calculated at $1.041 per sq yd, which may be considered as the probable maximum cost under existing conditions. With the experience gained on this work, the cost could probably be reduced to or below $1.00 per sq yd.

TABLE III. SUMMARY OF PAVEMENT COST

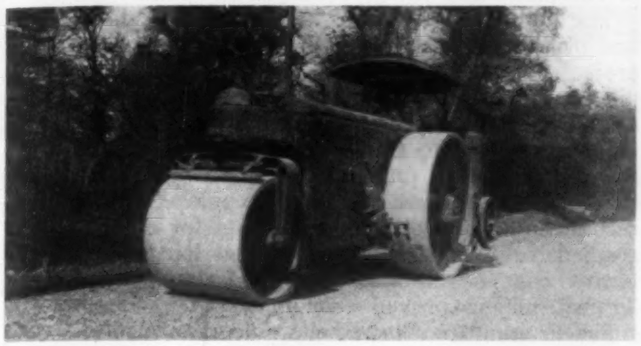
ITEM	COST	PERCENTAGE OF TOTAL COST
Labor	$ 1,557.60	15.5
Equipment	1,851.41	18.3
Materials	6,670.94	66.2
Total	$10,079.95	100.0
Cost per square yard	95.3¢	

A survey of this project during the first week of January 1933, to investigate cracking, revealed that no more had occurred than would be expected in regular concrete highway construction. Transverse joints placed at the time of construction had opened in a fairly regular manner above the wooden strip incorporated in the pavement. The longitudinal joint had opened only at a few places.

RECOMMENDED FUTURE CONSTRUCTION PRACTICE

As a result of the experience obtained on the construction of this particular project and of observation of similar work on other jobs, specific recommendations are offered as a guide to future construction of this type of pavement. Old Hassam cement-macadam pavements of 6-in. thickness have apparently given satisfactory service over long periods of time under heavy-duty traffic. It is therefore expected that with improved technic and materials this same thickness will prove satisfactory today, particularly for many secondary roads for which this type may be used. Where uniform subgrade conditions cannot be secured and where particularly heavy traffic is anticipated, consideration should be given to the probable advantage of thickening the edges to 8 in. If the edges are thickened, dowel bars across the center joints will probably be advantageous.

Wooden strips fastened to the subgrade were used years ago for crack control on Hassam pavements.



Ten-Ton Gas Roller Compacting Stone

Stone Was Well Rolled to a Thickness of Six Inches Prior to Grouting

So far, on the test sections of cement-bound macadam built to date, they have functioned as expected. It is important from the standpoint of appearance that the practically unavoidable longitudinal crack be controlled for direction. The location of the road and other conditions will determine the desirability of using transverse contraction or expansion joints and the extent to which they should be employed.

Table IV. Summary of Total Road Cost

Item	Cost	Percentage of Total Cost
Excavation	$ 2,360.15	17.4
Drainage	239.53	1.7
Pavement	10,079.95	74.4
Shoulders and clean-up	898.63	6.5
Total	$13,578.26	100.0

The size of the stone is important, in that all material passing a 1½-in. screen should be omitted. Small stone will accumulate in the bottom voids of the larger stone and tend to interfere with, or prevent, proper penetration of grout. In order that segregation may be reduced to a minimum, a uniform-sized material is desirable. It is therefore recommended that the stone be specified as passing a 2¾-in. screen and retained on a 1½-in. screen. A uniformly larger size will also probably give satisfactory results, such as that passing a 3½-in. screen and retained on a 2-in. screen. The usual specifications for concrete sand as passing a ⅜ or ¼-in. sieve will be satisfactory for grouting purposes. Stone for this class of construction may be of the ordinary kinds used in concrete or macadam pavement construction. Soft stone and other types that fracture easily during manipulation should not be used.

Early Hassam Pavement in Connecticut Carries Heavy Traffic

Shore Route 135 (Norwalk to Southport), 16 Ft. Wide and 6 In. Thick, Was Built in 1914, and Is Still in Good Condition

It is desirable that the spreading of the stone and pouring of the grout be carried on simultaneously and that only enough stone be placed ahead for one day's grouting. This is essential because the constant passage of grout trucks over the stone course will have a detrimental effect on it due to wearing action, disturbance of the surface, and accumulation of foreign material. Rolling is essential only to the extent necessary to smooth the surface, and should be reduced to a minimum prior to the application of the grout. The profile and contour of the stone should be checked with a 16-ft straight-edge and crown board, and irregularities should be corrected after the rolling has been completed.

Table V. Daily Pavement Production Data

Date Oct. 1932	Station to Station	Length	Loads of Grout at 2 Cu Yd Each	*Sacks Cement	Sacks Lin Ft
10	34+92—38+55	363	17	340	0.94
11	38+55—42+37	382	16	320	0.84
12	87+82—83+02	480	27	540	1.12
13	*83+02—76+32	670	37	740	1.10
13	42+37—43+70	133	6	120	0.90
14	43+70—53+73	1,003	46	920	0.92
15	53+73—65+29	1,156	58	1,160	1.00
19	65+29—72+22	989	52	1,040	1.05
19	73+36—76+32	...	..	....	...
19	*72+22—73+36	114	6	150	†1.32
7 days	34+92—87+82	5,290	265	5,330	‡1.00

Average day's run, 755 ft. Average of 3 best days' run, 1,087 ft.

* 1:2 mortar grout used except as indicated.

† 1:1.6 mortar.

‡ Average on 1:2 grout section (3 sacks per cu yd of pavement).

In placing the loose stone, allowance in depth must be made for the compression of the stone into the subgrade under the roller. This will amount to about ½ in. or possibly more, depending on the character of the subgrade. At least 20 per cent of the loose depth should be allowed for compaction of the stone and loss into the subgrade.

The 8-ton tandem roller used on the Pennsylvania job gave very satisfactory results on both stone and grout. Probably a 5-ton tandem would be satisfactory for rolling the grouted sections. In an effort to secure smooth riding qualities, the stone on this particular proj-

Table VI. Depth of Penetration of Cement Grout, as Determined from Cores

Core No.	Station No.	Depth Stone	Effective Penetration	Unpenetrated Depth	Remarks
1 × 50	36 + 78	6.25	4.50	1.75	*a, b, g*
1 × 32	38 + 95	6.25	4.80	1.45	*a, b*
1 × 26	39 + 00	6.00	4.50	1.50	*a, b*
1 × 49	42 + 00	6.00	3.65	2.35	*a, d*
1 × 33	44 + 00	5.25	2.75	2.50	*a, d*
1 × 34	44 + 65	6.00	3.75	2.25	*a, d*
1 × 27	49 + 00	6.00	4.00	2.00	*a, d*
1 × 35	50 + 72	6.25	3.20	3.05	*a, d*
1 × 36	54 + 00	5.75	4.50	1.25	*a, d*
1 × 48	56 + 00	5.75	3.15	2.60	*c, d, f*
1 × 28	59 + 00	5.75	3.40	2.35	*c, d, f*
1 × 47	59 + 50	5.25	2.25	3.00	*c, d, f*
1 × 46	60 + 00	5.25	4.00	1.25	*a, d, e*
1 × 37	62 + 00	6.25	4.55	1.70	*a, d, h*
1 × 38	64 + 00	6.00	4.45	1.55	*a, d, h*
1 × 39	68 + 95	5.75	3.90	1.85	*a, d, h*
1 × 29	69 + 00	6.25	3.90	2.35	*a, d, h*
1 × 40	72 + 00	6.25	4.00	2.25	*c, d, i*
1 × 41	73 + 00	6.25	4.70	1.55	*a, d, e*
1 × 42	75 + 78	5.50	3.90	1.60	*a, d, e*
1 × 30	79 + 00	6.00	4.55	1.45	*a, b, i*
1 × 43	80 + 40	6.25	5.50	0.75	*a, b, i*
1 × 44	84 + 00	5.75	4.20	1.55	*a, b, i*
1 × 45	86 + 00	6.25	5.25	1.00	*a, b, h*
1 × 31	87 + 00	5.75	4.75	1.00	*a, b, h*

a. Coarse stone.

b. Minimum initial rolling prior to grouting.

c. Fine stone.

d. Complete rolling, stone thoroughly interlocked prior to penetration.

e. Stone trucks turned at this point, requiring considerable reshaping and rolling.

f. Stone was noticeably fine and a number of truck loads were rejected.

g. Test hole taken at time of construction showed complete penetration.

h. Profile grade level.

i. Profile grade not level.

ect was rolled entirely too much with the 10-ton three-wheel roller.

In addition to low cost, it is essential that cement-bound macadam should have an even surface. This can be secured by again checking the pavement, after the grout has been applied, with a 16-ft straight-edge and crown board and filling the low spots with small-sized stone, a size of about $^1/_2$ or $^5/_8$ in. being most satisfactory. It is also essential that the accumulation of mortar on the surface be reduced to the very minimum. This can be controlled by regulating the amount initially spread from the trucks and by removing the excess during finishing operations.

Most of the old Hassam pavements were constructed with wooden side forms. It has been estimated that the cost of such forms, including material, labor, and equipment, will not be more than 2 or 3 cents per sq yd of pavement laid. To a very great extent, this will offset the extra cost required in the original grading and preparation of the shoulders with vertical edges to retain the stone without forms. If side forms are used, it might be more economical to construct the shoulders after the pavement has been completed. The use of forms will unquestionably give the edges of the pavement a better appearance and will tend to ensure penetration with a minimum of honeycombing. If there is any, it can be corrected after the forms are removed. The use of forms will also facilitate the finishing and belting of the surface. It is therefore recommended that wooden forms be given a trial on construction of this type to ascertain whether their advantages compensate for any possible additional cost, bearing in mind that this type of pavement must be constructed with as few "frills" as possible if it is to compare favorably with other types of low-cost construction.

One of the most surprising features of this particular project is the fact that the entire pavement was constructed with common labor, the only experienced road builders on the job being the foreman in charge of the plant and the foreman on the road.

The unloading plant was very primitive, as shown in one of the illustrations. Owing to the length of the project, the cost of special bins, a crane, and stock piles was not justified. A pump forced the water through a pipe line to barrels on top of a platform, whence it was fed by gravity into the transit mixers. There were no real delays due to difficulties with the plant except on two occasions, when the water pump failed. It is recommended that the requirements for equipment be studied carefully for each individual job to ensure the lowest cost possible to secure continuous operation. Transit mixers proved economical to operate, and a sufficient number should be provided to ensure a continuous supply of grout on the road. Delays from this source will prove very expensive.

It is desirable that the discharge chute, or other equipment for unloading the grout trucks, should be so constructed that a uniform and constant flow of cement grout will be secured. It is apparent that improvements can easily be made in the equipment used on this job.

ACKNOWLEDGMENTS

Both thanks and appreciation are extended to J. R. Fairman, Manager of the Eastern office of the Portland Cement Association, and to L. E. Andrews, Assoc. M. Am. Soc. C.E., Engineer of the same office, who compiled information and furnished photographs that were of inestimable value in the preparation of this article.

HOPPER OF 20-SACK CAPACITY AT CAR-FLOOR LEVEL
With Special Outlet Device for Charging Transit Truck Mixers

TRUCK MIXER CARRYING 3.6 TONS OF GROUT
These Trucks Traveled Over the Stone to Point of Discharge

16-IN. STRAIGHT-EDGE DETECTS SURFACE UNEVENNESS
Hollows Filled with $^5/_8$-In. Stone from Stock Piles on Shoulders

WET BURLAP STRIPS PLACED ON FINISHED SURFACE
Grouting, Rolling, Finishing, and Curing Operations Shown

Progressive Silting of a River Delta Studied

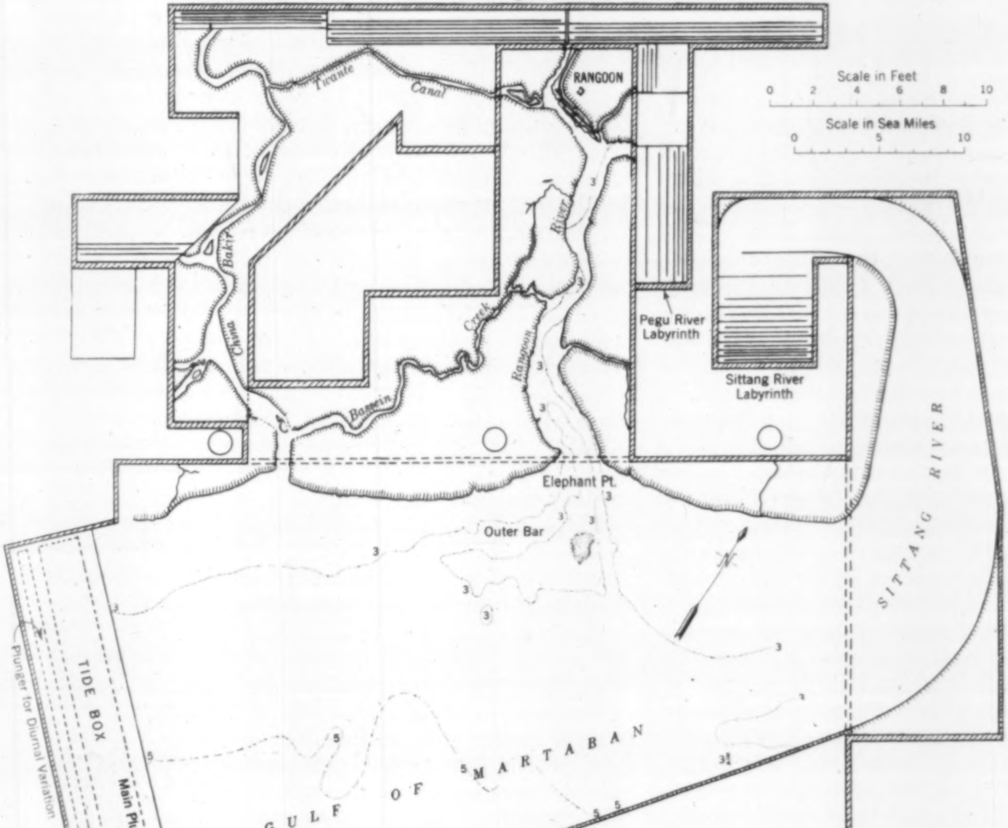
Tidal Model Built in London to Predict Conditions at Mouth of Rangoon River, Burma

By Herbert H. Wheaton

Associate Member American Society of Civil Engineers
Freeman Traveling Scholar for 1932

FOR the study of the silting of the channel at the mouth of the Rangoon River, Burma, an unusual model is being constructed in London. In it all the natural phenomena of tides, currents, winds, and flow are to be reproduced. Mechanically operated plungers will simulate the tides; electric fans will produce the monsoons; and the flow of the rivers will be imitated by regulation of the intakes, in which a labyrinth of baffles will represent the tortuous reaches of the rivers flowing into the Gulf of Martaban. The model is arranged to complete a tidal cycle in 76 sec, so that a week's operation will represent 10 years. The model is being constructed to simulate the delta as it was in the surveys of 1877 and will be operated long enough to indicate the conditions expected in the year 2000 if no improvements are made. Such alterations will then be made as are found necessary to keep the mouth of the river flushed out. Sir Alexander Gibb and Partners, who have verified the statements made in this report, but are not otherwise responsible for it, have, with the permission and approval of the Commissioners for the Port of Rangoon, courteously offered to members of the Society the privilege of visiting their model during its operation. Members desiring to avail themselves of this interesting opportunity should communicate with the Secretary of the Society, through whom the necessary arrangements will be made.

THE model of the mouth of the Rangoon River, Burma, now under construction at University College, London, by Sir Alexander Gibb and Partners, Consulting Engineers, is the largest of its kind that has yet been built in the British Isles. It is roughly 40 by 50 ft in horizontal dimensions, with a horizontal scale of 9 in. to one nautical mile and a vertical scale of 1 in. to 16 ft, the vertical exaggeration being 42 times. The difference in water level at Rangoon between mean high and mean low tides is over 20 ft, which, with the vertical scale adopted, corresponds to a difference of about $1^{1}/_{2}$ in. in the model. This is as small a difference in tidal range as could be depended upon to give satisfactory results in the operation of the model.


China Bakir Labyrinth
Rangoon River Labyrinths
Twante Canal
RANGOON
Scale in Feet
0 2 4 6 8 10
Scale in Sea Miles
0 5 10
Bakir
China
Creek
River
Rangoon
Bassein
Pegu River Labyrinth
Sittang River Labyrinth
SITTANG RIVER
Elephant Pt.
Outer Bar
3
3
3
3
3
3
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$3\frac{3}{4}$
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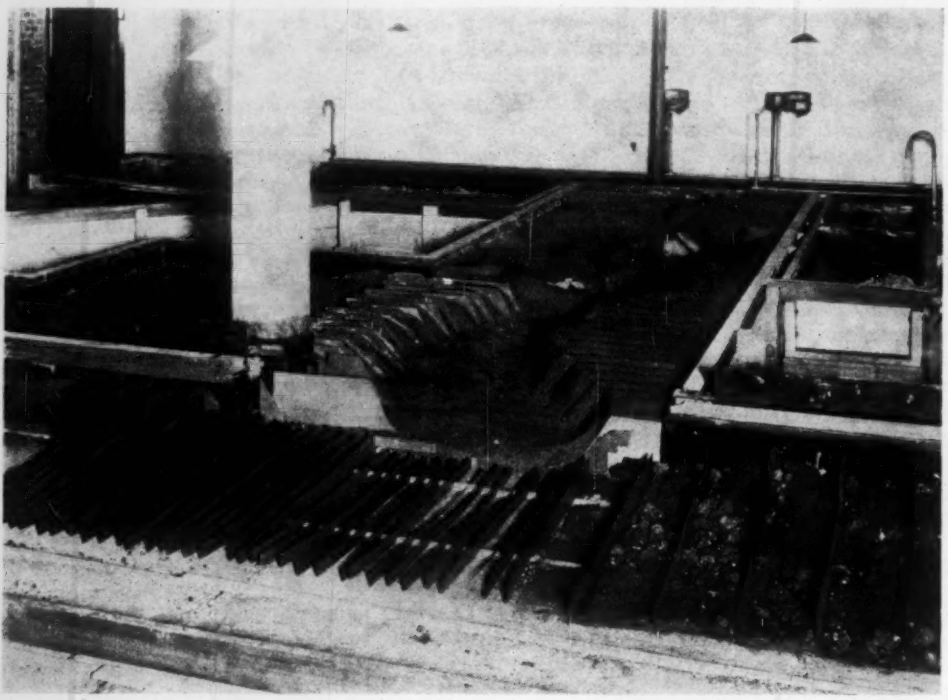
6
6
$6\frac{1}{4}$
6
6
6
6
GULF OF MARTABAN
TIDE BOX
Plunger for Diurnal Variation
Main Plunger

FIG. 1. PLAN OF MODEL OF THE MOUTH OF THE RANGOON RIVER, BURMA
Area Represented Is About 50 by 65 Miles

The Irrawaddy River, 90 miles west of the Rangoon River, discharges through many tributaries in a large delta, the Rangoon River being from one point of view the most easterly mouth of the Irrawaddy, though it has also its own drainage area and is joined at Rangoon itself by the Pegu River. The country is mainly low and marshy near the river mouths but there are areas of laterite rock at or above the surface in some places. The Irrawaddy is rapidly extending its delta and the consequent deterioration of channels is affecting the Rangoon River. The Irrawaddy carries a great quantity of fine silt in suspension, especially during the monsoon period.

ACCELERATED DETERIORATION AT RIVER MOUTH

Between 1870 and the present, during which period the Rangoon River has been used for a large amount of shipping, there has been in general a satisfactory, though slowly deteriorating, condition of the channel and bar near the river mouth. In the last 10 years, however, this deterioration has accelerated. At present the area of shallow water that is broadly designated as the outer bar, is about 7 miles wide and reaches entirely across the river mouth. It apparently shows no material variation with seasonal changes in the flow of the Rangoon River, and seems to be mainly due to the sediment carried along the shore in an easterly direction from the other mouths of the Irrawaddy to the west.



TIDAL MODEL OF THE PORT OF RANGOON, UNDER CONSTRUCTION, SHOWING RANGOON RIVER

East of the mouth of the Rangoon, at the head of the Gulf of Martaban, is the mouth of the Sittang River, which has a large tidal flat at the head of the bay. Rapid changes in its régime have taken place within recent years, its length having been reduced by 70 miles by the natural short-circuiting of loops. It has built at its mouth a vast salt marsh, which is exposed at low tide, is impossible of navigation, and is so far entirely uncharted. The mouth of the Sittang is very unstable and at one time was many miles west of its present position.

The first fully detailed surveys of the Rangoon and its surrounding area were made about 1877. Later surveys were made in 1883, 1897, 1900, and at frequent intervals since that time. Surveys of the river above the city of Rangoon have been made, and stream discharge measurements have been taken, only during the last few years.

The tides sweep into the Gulf of Martaban from the southwest and increase in height near the apex of the triangular bay. There is a marked diurnal variation in the height of the successive tides. Over the greater part of the gulf the depths of water are from 12 to 15 fathoms, so that no effect is produced on the profile of the tidal wave. Over the river bar at the mouth of the Rangoon, however, the depths average only 3 or 4 fathoms and the shape of the tidal wave is influenced. The prevailing tides and ocean currents are parallel to the shore at the river mouth. Because of the rapid constriction in area and depth of the gulf at the entrance of the Sittang, a very pronounced bore or tidal wave about 6 ft high is formed at certain periods and travels up the river at a high speed.

The material forming the Rangoon bar is in places very fine, about the fineness of portland cement. The maximum-sized grains in the deposits average about 0.01 in. in diameter.

The model is constructed on a platform about 3 ft above the floor, supported by posts and beams. The platform has a teakwood rail around the sides, which are about 18 in. high. This rail is accurately leveled and is used as a datum for the soundings. To prevent leakage, the inside of the whole platform is coated with $^3/_4$ in. of asphalt, laid in two layers. All the resulting construction was tested for water-tightness and found satisfactory. Battens, laid on edge on the table about 2 ft apart, are held in place by about 2 in. of concrete. The tops of the battens were leveled and on them templates were placed, which served as guides for the construction of the concrete base of the model. Everywhere the model bed was left 3 or 4 in. below the elevation of the final surveys so that there would be a sufficient depth of sand when the model was finally molded to allow for all possible scouring or other alteration of the deposits. In places where the most serious scour could be expected, a 6-in. depth was left. For this base construction, cinders and clinkers were used, covered to a depth of 2 or more inches with 1:4 concrete, in which the maximum size of aggregates was $^3/_4$ in. All was surfaced with a 1:4 mortar and painted with hot paraffin wax to give greater water-tightness to the concrete.

The sand in the model will be shaped to the desired profile by means of templates, which will be suspended from a carriage supported on the rails along the sides of the model. The sand will be molded up to the template, which should give more satisfactory results than the usual method of placing a template or vertical stakes in the sand.

The selection of the proper sand for use in the model is of course dependent primarily on the experience and judgment of the experimenter, and its size is closely related to that of the sand actually found in the river. Samples of sand were obtained from the Rangoon River and closely investigated under the microscope for size, elongation ratio, and grading.

The first trials will be made with a silica sand of appropriate size and grading from Cornwall. Sand from this source has proved satisfactory for similar tidal model work in the laboratory of Prof. A. H. Gibson at Manchester. The sand to be used has an average size of grain of about 0.008 in., and the grains have an elongation ratio of about $1^1/_2$.

The model will contain the mouths of the Rangoon, Sittang, and some other lesser streams that flow into the Gulf of Martaban. The accompanying sketch and photographs show the ingenious method that will be used to reproduce the proper tidal effect on the river and the effect of the river on the tidal prism. At the edge of the model each stream will flow from a baffle box in which it will travel a considerable distance, comparable to its length up to a point above any possible tidal effect. The distance apart of the baffle walls, as shown in Fig. 1, is in general greater near the mouth of the stream. An effort was made to have the distance between the baffles equal to the mean width of the river in the stretch represented. The curves are 180°, but the box in each case is so shaped that the total curvature in it is about equal to the total curvature in the section of the river represented. The bottom of the box will contain sand, which will be adjusted to the proper slope as will also the gradient of the water surface. The apparatus should give an indication of how far upstream tidal effects are felt.

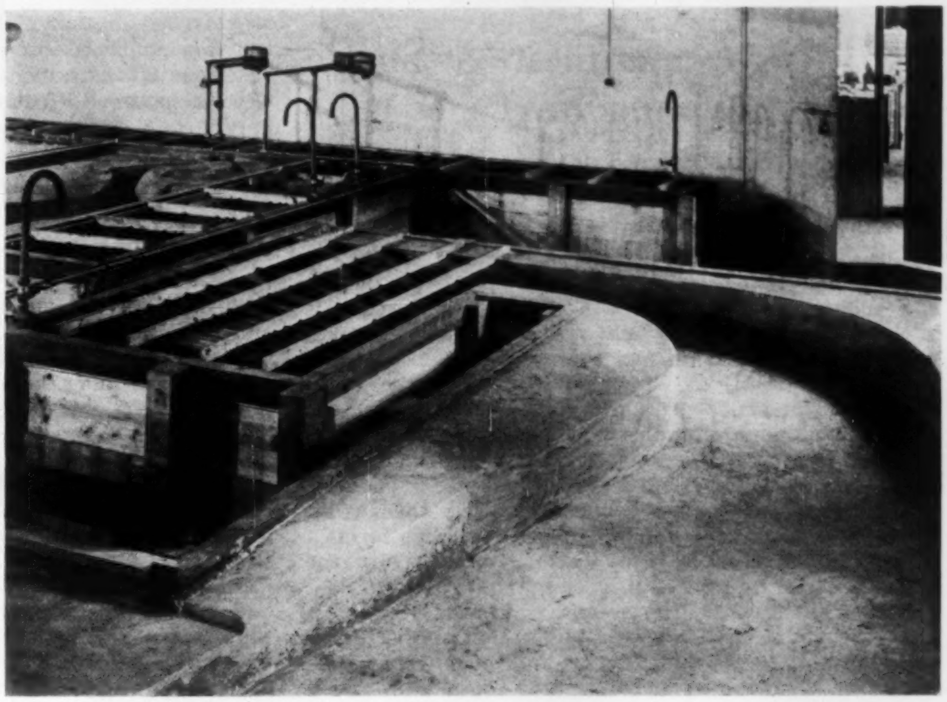
Because of space limitations in the room where the model is being constructed, the entire mouth of the Sittang River is not shown. Therefore the outside wall of the model is so built as to maintain the same proportional width, from shore to shore, of the upper end of the bay and the Sittang River at all points.

TIDAL EFFECTS TO BE SIMULATED

Plunger tanks for the generation of the tides are operated by an epicyclic gear and cam mechanism, specially designed. The model requires two plungers: one to displace enough water for each tide to raise the water surface to a height corresponding with the proper high tide, and the other, a smaller plunger working at half the speed of the main plunger, to produce the diurnal variation in the tides.

The gear mechanism automatically produces the spring and neap tidal variations as well as the daily range. The plunger stroke can be adjusted until the proper profile of the tidal wave is obtained. Baffles will be placed in positions such that all the principal currents will be simulated, and the proper direction given to the tide at every point. Surface waves during storms will be made by a hand-operated wave generator. Prevailing monsoon winds will be imitated by electric fans. The wind conditions must be subjected to experiment until the fans produce the proper effect on the water surface. The tidal machinery will operate an electric mechanism which, at the appropriate period, will vary the river flow entering the model so as to differentiate between monsoon and dry periods. An overflow weir will also be automatically operated to maintain a constant mean-tide level in the model.

Extensive experiments are being carried out on different materials to secure a mixture that will give the proper rate of bank erosion along the rivers. Sand will not maintain a steep slope; clay will slump when wet; and most mortars will not erode rapidly enough. At present many samples of very lean mortars are being tried, with mixes as low as 1:200. Blocks of the various materials are placed on a curved channel, in a rocking tank in which the reversal of flow of water and velocities comparable to those in the model are reproduced.



Labyrinth in the Sittang River Intake
Mean Width of Entering Rivers Represented by Distance Between Baffles
Number of 180-Deg Bends Equals Total Curvature in River Section Represented

The time scale of the model for a complete tide is about 76 sec, so that one week's operation will represent approximately 10 years. The model will first be adjusted to conform to the conditions in 1877, as recorded by the survey of that date, and runs will then be conducted to cover the period up to the present time. The necessary adjustments will be made in the model until the operation will reproduce the changes that have occurred in nature within this period, according to the records of the various surveys. It will then be run to a period corresponding to the year 2000, with no alterations such as training walls or jetties built at the river mouth.

Certain parts of the Rangoon River bed and banks will be formed with colored sands so that the travel of the eroded material and its influence on the outer bar can be traced. Similarly, the sea silt and the river silt will be of different colors in the model in order to trace the effect of each on the deposition of silt at the outer bar.

After the general tendency of the deposition of sediment has been observed in this manner, alterations will be proposed if necessary. The model will then be re-adjusted to conform to the surveys of the present time and these improvements tried. It is too early now to predict the nature of such improvements. It is possible that upstream alterations and diversion of the discharge of other tributaries into the main Rangoon River at times of low flow might be sufficient to keep the river mouth flushed out. The effect of other possible remedial measures, such as training walls, groynes, and revetments, will also be studied. The model will be in operation in the early part of 1933.

ENGINEERS' NOTEBOOK

From everyday experience engineers gather a store of knowledge on which they depend for growth as individuals and as a profession. This department, designed to contain practical or ingenious suggestions from engineers both young and old, should prove helpful in the solution of many troublesome problems.

Two Instruments in a Single Leveling Party

By HOWARD S. RAPPLEYE

ASSOCIATE MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS

CHIEF, SECTION OF LEVELING, U.S. COAST AND GEODETIC SURVEY

DURING June 1932, a scheme for using two instruments in a single leveling party was tried out in the Columbia Summer School of Surveying, at Lakeside, Conn. The trial was the result of cooperation between the U.S. Coast and Geodetic Survey and Columbia University.

At the summer camp where Columbia University students in civil engineering receive their field training in the various branches of surveying, a course in geodetic surveying is given. In connection with this work, precise, or as it is now called, first-order leveling forms a part of the course. Under my direction as instructor, the students execute projects in leveling, triangulation, base measurement, and field astronomy, It was in connection with the first-order leveling that opportunity was found for the trial of the two-instrument method.

The usual first-order leveling party consists of a chief of party, who acts as observer; a recorder; an umbrella man or instrument carrier; and two rodmen. The bench-mark crew is a part of the organization but of course is working ahead of the observing party placing marks, and need not be considered as a part of the observing unit. This means that in the observing unit there are ordinarily four men beside the observer. Usually these men are not technically trained, so that, aside from the chief of party, there are four relatively untrained men in the observing unit.

Progress is limited in a party of this type by the rapidity with which the observer can set up the instrument, observe, and have the instrument carried forward to the next station. There is usually no difficulty encountered in having the other members of the party in place and ready as needed. The two-instrument program of observing necessitates the addition of one more man to the party, an instrument carrier or umbrella man, and obviously any increase in progress must be greater than the cost of the extra man before it is justified.

In the trial at the Columbia Summer School of Surveying, it was a simple matter to assign another student to the observing party, and the extra instrument was easily made available. The two instruments were not identical but were so nearly alike that they could be used in alternation without hampering the observer. A description of the trial, which covered about a week's work, follows.

In starting a line from a bench mark of known elevation, Rod No. 1 was placed on the initial bench mark. Instrument A was then set up by Carrier A at the appropriate distance along the line. Rodman No. 2 paced the distance from Rod No. 1 to Instrument A, proceeded along the line for the same number of paces, and drove his turning pin. Rod No. 2 was then held on this pin and the observations were begun with the observer at Instrument A. While these observations were in progress, Instrument B was being carried an appropriate distance ahead of Rod No. 2, and was set up and rough leveled by means of the spot bubble. Both instruments were covered with cloth hoods except when actually in use for observations, when they were protected by an umbrella.

On completing the observations with Instrument A, the observer slipped the cloth hood over the instrument, took the umbrella from the man who had been holding it, and proceeded toward Instrument B. Rodman No. 1 immediately moved up to the position of Rod No. 2, paced the distance to Instrument B, and proceeded the same distance ahead for the next turn. The man who had held the umbrella for the observations with Instrument A picked up the instrument, carried it ahead of Rod No. 1, as located after it was moved, set the instrument up again, and rough leveled it.

On leaving Instrument A, the observer proceeded to Instrument B, handed the umbrella to Instrument Carrier B, who had carried the instrument to the station and rough leveled it, slipped off the cloth hood and began the observations with Instrument B.

It will readily be seen that the two instruments "leap-frogged" over each other along the line in the same way that the rods usually proceed. The observer, instead of having to wait until the instrument had been carried forward and leveled, as in the usual procedure, always had an instrument set up ahead and waiting for final adjustment and observing as soon as he could complete his previous observations and walk forward to it.

Progress under this scheme, as compared with the records of the previous six seasons of the same kind of work by similar groups of students, was about 30 per cent faster than that when a single instrument was used in observing. This leveling was done over roads where steep grades were often encountered. As sights were relatively short, the rodmen had ample time to walk ahead to their new stations while the observer was covering one instrument and proceeding forward to uncover and perfect the leveling of the other.

On longer sights, such as are encountered on work along railroads, it might even prove advantageous to use three rods, always having one rod and one instrument proceeding forward independently at all times. This would mean that each rod would stay on its turning point as usual, and that the rods would come into use in the order, 1, 2, 3, 1, 2, 3 . . . , while the instruments would be used in the order, 1, 2, 1, 2 . . . .

From the cost standpoint, the addition of the extra man increases the cost of the party from 10 to 15 per cent. As noted, the increased progress in the trial at Camp Columbia was about 30 per cent, but this percentage will vary considerably under different conditions. When allowance is made for the fact that a new observer used the instruments each day and that a student observer would be much slower than a trained and experienced man, it does not seem unreasonable to assume that under proper conditions progress might be increased 50 per cent by adding to the party one instrument and a man to carry it ahead and rough level it.

If an increased progress of from 30 to 50 per cent or more can be gained by an increase of only 15 per cent in the cost of the party, it is clear that the scheme can be advantageously adopted on leveling projects of sufficient size to warrant the provision of a second instrument.

Even on leveling of a lesser order of accuracy, where great care and refinement are not needed, the scheme of having two instruments and three rods might work to advantage on long lines of differential leveling. Where many side shots are to be taken, as on profile work, the method would clearly not prove advantageous and might increase rather than lower the cost per mile of progress.

Graphical Analysis of Stress in a Reinforced Concrete Section Under an Eccentric Load

By H. E. von Bergen

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For the determination of stresses in the steel and concrete of a reinforced concrete beam or column under bending and axial load, the following graphical solution is simple and easy and has a great advantage over the analytical solution, especially when tension exists over a part of the section and when the section is symmetrical about only one axis. The method was proposed by Mohr and translated from Prof. Dr. E. Mörsch's *Der Eisenbeton Bau* (fifth edition, 1920, Vol. I, page 450).

The solution is applicable to any section when the component of the resultant normal to the section lies on the axis of symmetry and either inside or outside the "kern." In Fig. 1 the point of application of V, the normal component of the resultant, lies on the axis of symmetry AB. The neutral axis of the section is perpendicular to it and at a distance, e, from V.

Location of the neutral axis, the first step toward the solution, is done in the following manner. The elementary areas of the concrete and n times the area of steel are represented in Fig. 1 as forces in the ray polygon on the left, which is constructed on an arbitrary pole distance, H. The pole distance should be about one-third the length of line representing the total summation of the elementary areas. Beginning at A, draw the strings in the funicular polygon $A''GLB'$, corresponding to the areas of the concrete, and from B' to A' draw the funicular polygon corresponding to n times the areas of steel. The line $A'C'$, parallel to the last ray of the "force" polygon, is extended to meet the line of application of V. The line $C'G$ is then located by trial, making the area $GC'L$ equal to the area $B'LA'$. Then GK lies on the line of the neutral axis or the line of zero stress.

The formulas for maximum stresses in concrete and steel are:

$$f_c = \frac{C_c V}{HZ}$$

$$f_s = n\,\frac{C_s V}{HZ}$$

in which H is of the same scale and dimension as the elementary areas, and Z is of the same scale and dimension as C_c and C_s.

The accuracy of the method may be proved by the following process of reasoning. If in Fig. 1 any small elementary area is denoted as dA, which is an element of transformed area consisting of the area of concrete and n times the area of the steel, and its distance from the neutral axis is taken to be x, then, for static equilibrium, the summation of the forces normal to the section and the summation of the moments about the neutral axis will be shown by the two following equations:

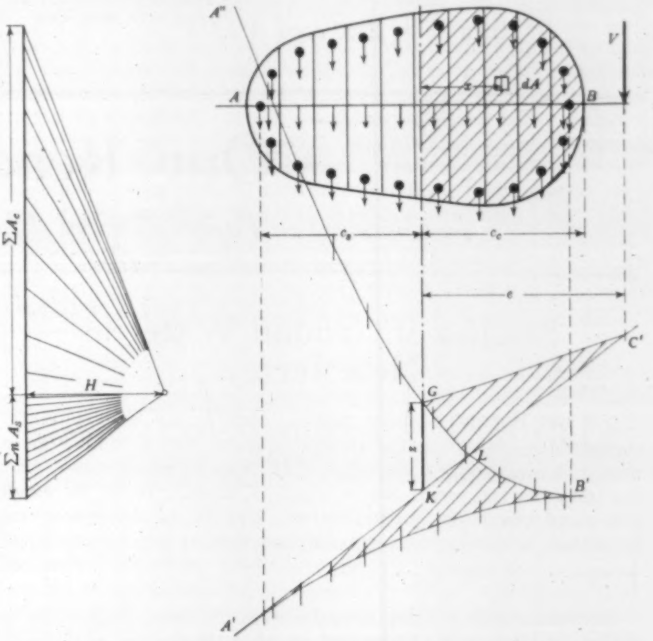


Fig. 1. Plan of Concrete Section and Method of Solution

$$V = \Sigma f dA = \frac{f}{x}\,\Sigma x dA \,\ldots\ldots\ldots [1]$$

$$M = Ve = \Sigma f x dA = \frac{f}{x}\,\Sigma x^2 dA \ldots\ldots [2]$$

Since the unit stress, f, at any point on the transformed section, acting at a distance x from the neutral axis, is directly proportional to x, the ratio $\frac{f}{x}$ is a constant for any given external load.

By substituting for V in Equation 2, the equivalent of V found in Equation 1, the following equations may be written:

$$\frac{f}{x}\,\Sigma x dA \;\; e = \frac{f}{x}\,\Sigma x^2 dA \,\ldots\ldots\ldots [3]$$

$$\text{Therefore} \qquad e = \frac{\Sigma x^2 dA}{\Sigma x dA} \,\ldots\ldots\ldots [4]$$

Since $M' = \Sigma x dA$ (first moment of area) and $I = \Sigma x^2 dA$ (second moment of area), therefore

$$e = \frac{I}{M'} \,\ldots\ldots\ldots\ldots [5]$$

The statical moment of the area of the concrete in compression and of n times the area of the steel, M', is graphically the intercept, GK, times the pole distance H. Therefore:

$$M' = HZ \ldots\ldots\ldots\ldots [6]$$

Also, when GK is the neutral axis, the moment of inertia of the area of concrete in compression and n times the area of steel about this axis equals, by graphical solution, twice the area $A'KGB'$ times the pole distance H. Or $I = 2H \times \text{area } A'KGB'$ and by Equations 5 and 6,

$$e = \frac{I}{M'} = 2H \times \text{area } \frac{A'KGB'}{HZ}$$

then $eZ = 2 \times \text{area } A'KGB'$

Also, from Fig. 1,

$$eZ = 2 \times \text{area } C'KG$$

Therefore area $C'KG = \text{area } A'KGB'$

Since the area GLK is common to both areas, then Area $C'LG = \text{area } A'LB'$

This method of analysis has been found to be both useful and rapid and is the simplest of any that I know of.

Our Readers Say—

In Comment on Papers, Society Affairs, and Related Professional Interests

Studies of Ground Water in New Jersey

TO THE EDITOR: In his paper, "New Jersey Ground-Water Supply Abundant," in the December issue, Mr. Critchlow gives statistics illustrating a condition that exists in many states, that the majority of public water supplies, mostly those for small cities and towns, use ground water. But the total consumption of surface water is much greater than that of ground water because the water supply of practically all the large cities is obtained from the surface.

Because of the relation between geologic and hydrologic conditions, in many localities the same water-bearing formation may be drawn upon by communities distributed over a large area. As a result of certain principles of hydraulics, the unfavorable effects of pumping likewise may be felt over a large area. Accordingly, the problems of ground-water development in a given locality may be closely related to those of a much larger area.

For many years following the early development of ground-water supplies, investigations by the U.S. Geological Survey and the geological surveys of the several states were largely of a qualitative nature, to determine such data as the geologic conditions under which the water occurred and the depth to the water-bearing formations. In more recent years there has been an increasing demand for investigations more quantitative in nature to find how much water can be drawn from the formations for a long period of years without exhausting the supply or creating uneconomic pumping lifts, or, in some localities, without drawing water of poor quality.

The State of New Jersey, through the State Geological Survey, and its successor, the Department of Conservation and Development, performed its duty well in the collection of data of a qualitative nature; and there are now available records of more than 3,000 wells in different parts of the state. The need for quantitative studies, in general, was realized earlier in the Western states, where large quantities of ground water are used for irrigation, than in the more humid East, and many quantitative investigations have been made in these states.

I believe that I am correct in saying that, except for the classic studies of Freeman, Spear, Veatch, and others, of the ground-water supplies of Long Island about 1900, no extensive quantitative studies were made in the Eastern states until 1923, when the investigation of selected areas was begun by the New Jersey Department of Conservation and Development in cooperation with the U.S. Geological Survey. At this time there was no precedent to suggest methods of approach to some of the problems, and it was necessary to develop new methods that could be used under the conditions encountered.

The authorities of the State of New Jersey who are responsible for the formulation of a policy for the wise development of the water supplies of the state, which constitute one of its most valuable natural resources, are to be commended for the attention they have given to the quantitative studies of ground-water supplies. It is to be hoped that these studies may be continued and extended, for there is ample evidence that the results will be well worth the cost. In recent years the need of similar investigations in other states has become apparent, and the State of New Jersey has set a good example for them to follow.

DAVID G. THOMPSON
Senior Geologist, U.S. Geological Survey

Washington, D.C.
December 27, 1932

Water Supply of Chester, Pa.

TO THE EDITOR: Mr. Freeburn is to be complimented on his interesting paper, "Water Supply of Delaware County Menaced," in the December issue. In describing the important developments in the history of sanitation in this county, Mr. Freeburn brings to light numerous interesting facts. The valleys of the Schuylkill and Delaware rivers are not only very highly developed industrial regions, but their watersheds include one of the most thickly populated sections of the United States. The water supply problems of the area have been complicated by the waste products of these industries and this population.

In his article Mr. Freeburn has called attention to the rapid increase in the population of Delaware County and has described the pollution of the various streams draining this county and discharging into the Delaware River. It is interesting to observe the methods which have been employed by the Pennsylvania State Department of Health in securing the proper disposal of sewage in this district. The early decrees of the department, ordering the construction of sewage-disposal works, did not produce the desired results. On the other hand, the enlistment of municipal interest in a cooperative plan, which disregarded political subdivisions, has resulted in active construction work on a number of projects. Throughout Mr. Freeburn's discussion of the various projects planned and the achievements which have resulted the important part played by the State Department of Health is obvious.

Within the last few years the City of Chester has taken the necessary steps to care properly for its industrial and domestic wastes so that these will no longer seriously affect its water supply. Mr. Freeburn has explained how the neighboring Delaware County communities are now in the process of caring for their wastes. It would seem that the next step in this cleaning-up process is the responsibility of the City of Philadelphia and its suburbs. The State Sanitary Water Board has conducted a thorough investigation of the industrial waste pollution of the Delaware River in the vicinity of Chester; and the Chester Water Service Company has cooperated in this investigation, particularly in connection with river studies to determine the zone of influence of the industrial wastes.

A historical sketch of the growth and development of Delaware County and the pollution of the Delaware River by the intensive development of its watershed above Chester reveals one of those modern tragedies of water supply which have become too common in our civilization. The City of Chester, ideally located with respect to the rich and populous upland and a riparian owner on one of our largest navigable rivers, has witnessed the gradual deterioration of its water supply as a result of the careless attitude of the vast community northeast of Chester in the disposal of its wastes.

Mr. Freeburn has pointed out that, in the past history of water supply in this country, there has been a tendency to develop sources of supply close at hand and then gradually abandon them to move upstream and escape pollution. He draws the conclusion that," . . . the Delaware River at Chester will eventually become unfit for use as a public water supply. . ." Should this happen, the cost of securing a new water supply would ultimately have to be borne by the water consumers in Chester. It is indeed unfortunate that a city should thus be forced to pay for a new water supply in order that neighboring communities may continue freely to use its original source of water for sewage-disposal purposes.

The sewage-disposal program for Delaware County and Philadelphia should result in some improvement in the quality of the Delaware River water at Chester. Since the water-purification plant is handling the present load successfully, it is to be expected that the Delaware River will continue to furnish a usable supply to Chester for some years to come.

George D. Norcom, Assoc. M. Am. Soc. C.E.
Sanitary Engineer, Utility Service
Staff Corporation

New York, N.Y.
January 7, 1933

New Jersey Handles Its Sewage Efficiently

To the Editor: In his admirable paper in the December issue Mr. Wigley presents a description of the sewage treatment of the New Jersey coast resorts. The New Jersey State Department of Health enjoys an enviable record for its method of handling the problem of sewage treatment along the coast as well as in the rest of the state. New Jersey is also established in the history of successful sewage treatment by Phelps' pioneer work at Red Bank in the disinfection of sewage.

Years ago sewage was often discharged directly into the ocean at the surf line, and bathing was somewhat hazardous. The next step was the construction of ocean outfalls to discharge the crude sewage at a distance from the shore. In 1908 various summer resorts along the Jersey coast were ordered by the state department of health to cease discharging crude sewage into coastal waters.

One of the early sewage treatment plants was established at Ocean Grove, and in 1908 settling tanks were constructed to treat the sewage previously discharged through a 12-in. outfall extending 1,300 ft beyond the high-tide mark. It is interesting to note that, even at this early date, disinfection of sewage was contemplated and a chlorine detention chamber was included in the plant. At the Ocean Grove plant, as at many others along the shore, the tanks were constructed at the ocean front and vented through a flagpole. This method has proved effective for plain settling tanks without the use of artificial ventilation. Hundreds of people walk by the tanks daily without realizing that they are in the vicinity of a sewage-treatment works. At one plant along the shore in which the tanks were covered by a concrete roof but had numerous manholes and a pump house and screen house above the ground, considerable complaint of odor was received. This condition was satisfactorily overcome by the installation of a flagpole 75 ft high, with a diameter of 12 in. at the top and of 18 in. at the bottom together with an exhaust fan, installed in one of the buildings, which discharged into the pole. The blower suction was connected by ducts to the various compartments, creating a slight suction at all openings.

The construction of ocean outfalls is an interesting but difficult procedure. Many of the early outfalls were of galvanized wrought-iron pipe with screw coupling joints protected in part by river clamps or cast-iron split sleeves. These were often assembled on shore and launched in one operation by carrying the pipe on rollers and trucks, either rolling it along the ocean bottom or floating it into position on pontoons. In recent years, cast-iron pipe with universal joints has come into favor for outfalls.

As Mr. Wigley states, the shore communities are unique in that flat sewer grades have been used and, in general, successfully. In many communities this has eliminated the necessity of pumping which in former days was a more formidable problem than it is at present owing to the type of pumps available.

The data presented by Mr. Wigley, indicating that the high bacterial count in the waters of the bathing beaches may be caused by the bathers rather than by the discharge of sewage, are most interesting. It would seem that the condition of bathing waters in the Metropolitan District is influenced by this factor which is not given proper consideration. Observation of crowded beaches when the water is quiet and floating trash remains in the same locality for long periods, indicates that some beach waters may not be as satisfactory as a well regulated swimming pool.

Clyde Potts, M. Am. Soc. C.E.
Sanitary Engineer

New York, N.Y.
December 26, 1932

Bacterial Standard for Natural Bathing Waters Needed

To the Editor: The paper by C. G. Wigley, in the December issue, is of particular interest because of the unusual conditions affecting the collection and disposal of the sewage of the municipalities along the New Jersey coast.

There is no accepted bacteriological standard for natural bathing waters. Much depends upon the source of the bacteria found. The time factor or proximity of sewage pollution is of great importance. Investigations made by the New Jersey State Department of Health, traced the sewage to the bathing waters and found B. coli content to the extent of 100 per cu cm. This demonstrates the need of chlorination.

There is a dearth of epidemiological evidence of disease caused by bathing in polluted waters. The data presented by Mr. Wigley, showing graphically the number of typhoid cases in New York City before and after the condemnation of polluted waters for bathing, are therefore most welcome, although it must be conceded that this is circumstantial evidence. Presumably only a small proportion of the total population of the city bathed in the polluted waters before they were condemned. It would be of interest to know what proportion of those contracting typhoid fever had bathed in the polluted waters. Probably other improvements in sanitation during this period of years caused a gradual reduction in the number of typhoid cases. Such a reduction would naturally be greatest in the summer months when the disease is most prevalent. Undoubtedly some typhoid cases resulted from bathing in the polluted waters.

This summer I had opportunity to investigate certain polluted lakes and streams in New Hampshire and to determine their sanitary condition and the extent and probable cost of any treatment of sewage and industrial wastes required to restore them to a condition suitable for such recreations as bathing and fishing. In these studies, no attempt has been made to establish a definite bacterial standard for the recreational waters. Conclusions will be based on the source, character, and amount of pollution and on the results of observations and of chemical and biological examinations correlated with the results of bacterial analyses. In certain cases where water supplies or the use of the water for drinking are involved, the requirements will be considered much more exacting.

It is sometimes said that natural waters to be safe for bathing should be fit to drink. Such a standard is not only impracticable of attainment, but unreasonable. The hazard of contaminated drinking waters is much greater than the hazard of contaminated bathing waters, and this is true for other reasons than the fact that only a small proportion of those using the drinking water come in contact with the bathing waters. The quantity of water taken into the system in drinking is many times that swallowed accidentally while bathing. With contaminated drinking water, exposure takes place several times a day and day after day, whereas exposure to contaminated bathing waters is only occasional and for a limited part of the year. These facts probably explain in large measure why there has been no more typhoid attributable to bathing in polluted waters.

The fact that the hazard of bathing in contaminated water is so much less than the hazard of a contaminated drinking water supply does not, however, justify the pollution of bathing beaches. No sewage pollution in the vicinity of such beaches should be permitted. Visible evidence of sewage pollution should not be tolerated even though the sewage has been brought considerable distances by winds and currents. Bathing waters should be maintained reasonably free from bacteria of known sewage origin.

ALMON L. FALES, M. Am. Soc. C.E.
Consulting Engineer

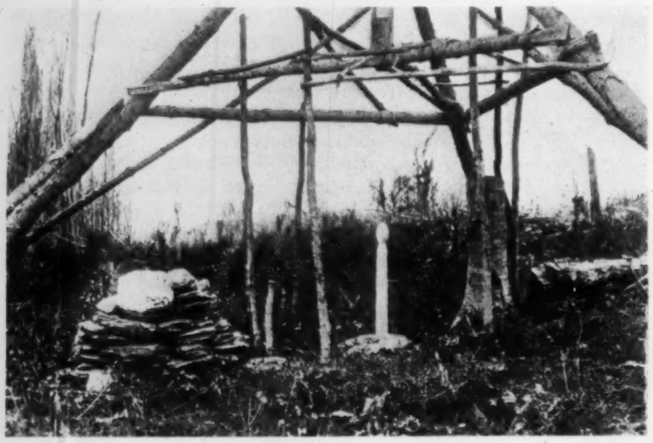
Boston, Mass.
January 6, 1933

Early American Boundary Surveys

TO THE EDITOR: In his splendid article in the December number, Mr. Shaw tells of the difficulty experienced in finding the monuments along the tangent line boundary between Delaware and Maryland, and expresses some surprise that "they were marked by the letter *M* on the far side and by the letter *P* on our side, showing that Delaware had been a part of Pennsylvania at one time." In this connection, I should like to point out that the U.S. Coast and Geodetic Survey Report for 1893 contains an article entitled "A Historical Account of the Boundary Line Between the States of Pennsylvania and Delaware," prepared by W. C. Hodgkins of that bureau in connection with studies made preparatory to reestablishing on the ground the circular boundary between the two states.

In this article Hodgkins states that Mason and Dixon, mathematicians sent over from England by the proprietors of Pennsylvania and Maryland to aid the commissioners in surveying the boundary lines between those colonies, "Accepting as settled the 'base line' which had already been measured across the peninsula by their predecessors, and the middle point marked by the same persons, . . . endeavored to run out the tangent line from the middle point of the base to the tangent point."

Continuing the quotation from Hodgkins: "As these various lines were located by Mason and Dixon they were marked by suitable stone monuments, which were generally one mile apart. This work was done by other persons under the supervision of the commissioners. These stones were made in England from oolitic limestone, and were sent out from time to time as they were needed. They are stout square posts surmounted by a rather flat pyramid. Upon the side facing Maryland the letter *M* is cut, and on the opposite side the letter *P*. As Delaware was then a part of Pennsylvania the whole length of the line was marked in the same way."



TRIANGULATION FLAG ERECTED OVER A MONUMENT ON THE STATE BOUNDARY BETWEEN MASSACHUSETTS AND NEW YORK

In the Towns of Hancock, Mass., and Stephentown, N.Y., on the Top of Mount Misery

The location of important boundaries has frequently been the subject of disputes—disputes that it often took years to adjust. The circular boundary of Delaware is no exception. Originally conceived to establish a line between the territory claimed by the Duke of York and land granted to William Penn, and later to define the boundary between New Castle County, Delaware, and Chester County, Pennsylvania, this unique boundary was not established beyond all further question and dispute until 1892, when Hodgkins reestablished it and referenced it to geodetic control.

Several monuments along the tangent line boundary of Delaware, as well as some three or four along its southern boundary, have also been connected to the geodetic control of the country, but making these connections was only incidental to one of the normal activities of the U.S. Coast and Geodetic Survey—establishing basic control data over the entire country and along its coasts. Such monuments as have been referenced to the national control surveys are well insured against loss, since the positions they occupied can be redetermined even if the material marks have been completely destroyed.

The great value of control surveys in establishing and maintaining boundaries was recognized some years ago by the U.S. Supreme Court, when the commissioner, charged with the survey of the 100th meridian boundary between the States of Texas and Oklahoma, secured the assistance of the Coast and Geodetic Survey in laying down this meridian on the ground. This was done by means of an arc of first-order triangulation run the length of the boundary, and made part of the national control survey. The geographic positions of the monuments along this boundary perpetuate their locations. This whole boundary may be considered one of the most scientifically determined lines in this country, if not in the world.

WILLIAM BOWIE, M. Am. Soc. C.E.
Chief, Division of Geodesy,
U.S. Coast and Geodetic Survey

Washington, D.C.
December 29, 1932

Advance Planning of Public Works

TO THE EDITOR: It is highly significant that several of the papers presented at the Fall Meeting of the Society, and later published in the December issue of CIVIL ENGINEERING, emphasize the broad economic importance of expenditures for public works construction, and the necessity for advance planning as a sound public business policy. We are on the threshold of a new era in the administration of public works, and the civil engineer, by reason of his training and experience, has a rare opportunity to exert leadership.

One of the reasons why cities are in distress today is that bonds issued during prosperity to provide funds for the creation of public works have impaired the credit of those communities. Some improvements are more important than others and bear a definite relationship to each other with respect to the sequence in which they should be undertaken; and this fact must be recognized in the formulation of any program of public improvements. In practice, however, the sequence has not always been decided according to relative merits or importance. Instead, the question of preference has been determined largely by the relative amount of pressure which is brought to bear in favor of one project or another.

By intelligently planning all public works several years in advance, a balanced program, which provides for the execution of public works in the order of their urgency as well as in accordance with the ability of the community to pay for them, can be formulated. Likewise such a program makes it possible during good times to defer such construction projects as can economically and conveniently be postponed until times of depression to provide employment. By keeping public works expenditures well within the financial means of the community, a conservative debt margin may be maintained for the purpose of strengthening the credit of the community for use in times of emergency.

Cities and states are seriously concerning themselves with this matter, and several official commissions are now engaged in studying ways and means of bringing about advance planning of their public works. The Federal Government by congressional enactment established the Federal Employment Stabilization Board for the express purpose of bringing about advance planning of all Federal public works—including maintenance, repairs, and alterations—six years ahead. We have progressed far enough to demonstrate the wisdom of the legislation and the practical value of this modern public service. The procedure developed by this board and the experience it has gained should prove helpful to states and cities desiring to establish methods of administering public works more efficiently, more economically, and for the greatest community good.

Advance planning of public works is here to stay. Who is going to do it? Will civil engineers broaden the scope of their city-planning activities to take in all public improvements, including school houses, fire stations, water supply systems, sewers, and all other physical enterprises involving construction which, for the most economical and orderly development of the city, should be made in accordance with an intelligent, well balanced program adapted to the financial resources of the community? To quote from Colonel Wetherill's paper: "The need for an intelligent engineering approach to the problem of expenditure of public moneys is greater than ever before."

D. H. Sawyer, M. Am. Soc. C.E.
Director, Federal Employment Stabilization Board

Washington, D.C.
December 15, 1932

Bamboo Bridges in Netherlands East Indies

To the Editor: On the first page of the November issue of Civil Engineering, you publish a photograph with the heading, "An Unusual Bridge," and a few lines from which I gather that doubt exists as to where this bridge is to be found. However, your assumption was in the right direction. In several parts of The Netherlands East Indies bridges of the same type exist—sometimes bigger, sometimes smaller, sometimes of a slightly different style. They are built by the natives of bamboo, the various parts being kept together by string, which in the native language is called "tali-dook." This string is made of the fiber from the stems of palm trees. It is a well known fact that one cannot hammer nails through bamboo, but holes can be made, and the string is passed through these. The bridge shown in the photographs is one of two over the Serajoe River in Middle Java, which flows from the famous old Dieng Plateau (where quite a number of Hindoo temples are to be found) in a westerly direction to reach the ocean off Tjilitjap, the center of the south coast of Java. Such bridges are built by the inhabitants of neighboring villages as a kind of duty on their part, generally without any payment for the work. Only the materials, which are of course very cheap, are paid for.

The span is about 130 ft, and the width from 3 to 5 ft. These bridges, which are used only by pedestrians and small horses carrying burdens, have but a short life, a few years at most. This must not be attributed to any flaw in the construction itself, but rather to the placing of the abutments and to insufficient lateral anchorage. The span is made as narrow as possible, with the consequence that the abutments are sometimes within reach of high water, and during severe floods they are either washed away or the anchorage is destroyed and the bridge collapses. This also happens at times when strong winds break the anchorages.

This is not the first time that American engineers have shown interest in this type of bridge. I have often walked over these bridges myself and like to think of them as fine expressions of intuitive engineering knowledge and almost a part of the landscape.

Wouter Cool
Koninklijk Instituut van Ingenieurs

's Gravenhage, Netherlands
December 21, 1932

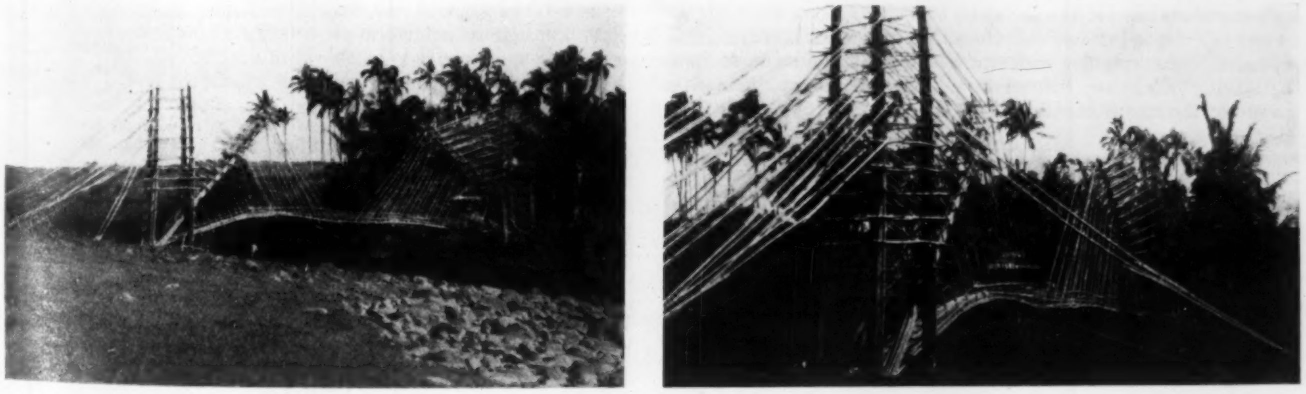
Three Basic Principles of Economic Recovery

To the Editor: At the Atlantic City Meeting, I listened attentively to the reading of the papers on "Economics in the Depression," by John P. Hogan, Malcolm Pirnie, and Frederick H. McDonald, and later diligently searched these articles, when they appeared in the December issue of Civil Engineering, for some mention or discussion of what I believe to be the three primary principles on which a start to recovery may be made, as well as a stabilized situation set up, which latter I consider equally as important as the return of prosperity. These principles, in my opinion, are as follows:

1. Abolition of all tax-free securities, recognizing that Congress can act only as regards those issued by the nation, but believing that it should gradually impose Government taxes on all at present non-taxable property and, by means of a constitutional amendment, make taxable all securities issued and salaries paid by either national, state, county, or municipal governments.

2. To make mandatory on all employers of a material amount of labor the setting up of a plan such as the "Swope Plan" as a safeguard for the wage earner's future; that is, compelling the deposit each pay day of a certain percentage of the laborer's wage, supplemented by a similar contribution from the employer. This deposit shall be made in some nationally created institution, where it will earn compound interest, with provisions that it may be paid to the individual in time of need, such conditions to be thoroughly described by the act of agreement.

3. Complete abolition in national, state, county, and city politics of the "pork barrel," to the extent that in the future little or no money would be spent on public works or enterprises unprofitable to the nation and its taxpayers. For example, the



Bridge Over the Serajoe River in Middle Java
Bridge Is Made of Bamboo and the Footway Springs When a Burden Passes Over It

Government in the last 40 years has spent on the Ohio River, between Pittsburgh, Pa., and Cairo, Ill., in the neighborhood of $150,000,000. The river has been completely locked to the extent of a 9-ft channel. They are now beginning to rebuild all the dams to provide deeper channel; and yet today Government engineers and river men acknowledge that, if a toll charge were made sufficient to pay the operating expenses of these locks and dams, nothing to be included for fixed charges, there would not be a boat on the river outside of the harbors of some of the larger cities along the route. Still every Congress passes appropriations for more such expenditures involving the wanton waste of national funds; to say nothing of many other similar schemes, such as veterans' aid and bonus, surplus Government employees everywhere, extravagantly organized governmental departments, congressional and official junkets, a pension list 50 per cent too large, and others.

J. N. CHESTER, M. Am. Soc. C.E.
The J. N. Chester Engineers

Pittsburgh, Pa.
December 15, 1932

Basic Community Surveys Needed Now

TO THE EDITOR: Local governments exist because the experience of some hundreds of years has taught us that we can more efficiently and economically provide ourselves with certain services through community financing and administration than in any other way. The variety of such services has increased with time not because of an overwhelming desire on the part of governments to dominate the lives of citizens, but because citizens have found that they cannot get what they need so well, if at all, by private effort.

This is a plea for communities to use these slack times, when it is desirable to keep engineering forces busy at something useful, for some fundamental survey work. To release a well trained engineering staff adds to the unemployment problem of a community, and unemployed engineers can do something better than digging ditches to earn their relief money. Set them to work on triangulations and traverses; get a whole set of bench marks established all over your town; and have profiles made of streets which are next in line for improvement.

A small amount in this year's budget for such work—as a part of a plan to carry forward the work regularly over a five-year period—will place the community in a position to be ready when the building rush comes again. The making of a few street profiles, the reestablishment of some vague street lines, and the planning of water works and street and sewer extensions each year will put a community in a position of readiness to provide the necessary basic data when better times permit the return to normal construction activity. And this fundamental surveying is something that the property owner cannot possibly get as cheaply for himself as he can through his local government.

To eliminate such work from the community budget is like reducing a fire department only to have insurance rates go up. It recalls the story of the town which recently eliminated municipal garbage collection, only to have the householder pay more for the service of private garbage collectors than the taxes saved.

Moderate but regular expenditures and employment in basic engineering work are helpful now, and will repay themselves tenfold in the course of a few years.

CHARLES ASCHER
Assistant Director, Public Administration Clearing House

Chicago, Ill.
January 10, 1933

Deflection Factor for Fully Restrained Beams

TO THE EDITOR: The article, "Beam Deflection by Substitution of a Central Load," by the late M. J. Shamray, in the June 1932 issue, interested me greatly, and I attempted to check the formulas and tables contained in it. I found, however, in the case of Formula 8 (on page 375), which gives $n = k^2(1 - k)$ for the conversion factor if the end B is restrained, that an error had apparently been committed, since the conversion factor as given is, according to my calculations, for the case of a beam which is fully restrained and carries a uniformly distributed load over a portion of its length.

The values printed in italics in Table II are obtained by the evaluation of this formula, and it is evidently meant that fully restrained beams are being considered rather than beams with only one end restrained.

LAWRENCE E. PETERSON, Assoc. M. Am Soc. C.E
Consulting Engineer

Milwaukee, Wis.
December 28, 1932

[*The point raised by Mr. Peterson has been verified by N. L. Shamroy, Assoc. M. Am. Soc. C.E., nephew of the late M. J. Shamray, M. Am. Soc. C.E.*]

Finding Elevations of Stations on Vertical Curves

DEAR SIR: I was very much interested in the article on "Calculating Vertical Curves by First and Second Differences" by Professor Carey, in the January number of CIVIL ENGINEERING. I have been teaching a similar method for finding elevations of stations on vertical curves. The method is based on the proposition that the change of grade of the vertical curve per station is uniform. Any uniform length may be used for a station.

Using 100 ft as a station, the problem in Professor Carey's article is solved as follows: the grades to be connected are +2.1 per cent and −4.3 per cent, and the length of the vertical is 8 stations. The change of grade per station is $\frac{2.1 - (-4.3)}{8} = \frac{6.4}{8} = 0.8$ per cent. The grade at Station 41 is +2.1 per cent. Applying the change of grade per station, the grade of the vertical curve at Station 42 is 2.1 − 0.8, or +1.3 per cent; and the average grade from Station 41 to Station 42 is $\frac{2.1 + 1.3}{2} = +1.7$ per cent. The difference of elevations of Stations 41 and 42 is 1.7 ft. The elevation of Station 42 is 560.13 + 1.70, or 561.83 ft. As the change of grade per station is uniform, the average grade of the vertical curve from Station 42 to Station 43 is 1.7 − 0.8, or 0.9 per cent. The elevation of Station 43 is 561.83 + 0.90, or 562.73 ft. The elevations of the other stations are found in a similar manner, as is shown in the following tabulation:

STATIONS	DIFFERENCES OF ELEVATIONS	ELEVATIONS
41	....	560.13
42	+1.70	561.83
43	+0.90	562.73
44	+0.10	562.83
45	−0.70	562.13
46	−1.50	560.63
47	−2.30	558.33
48	−3.10	555.23
49	−3.90	551.33

The check is obtained by finding the elevation of Station 49 from the elevation of the vertex of the vertical curve as follows:

Elevation of vertex = 560.13 + 4 × 2.1 = 568.53
Elevation of Station 49 = 568.53 − 4 × 4.3 = 551.33

This solution may be of interest to students of civil engineering.

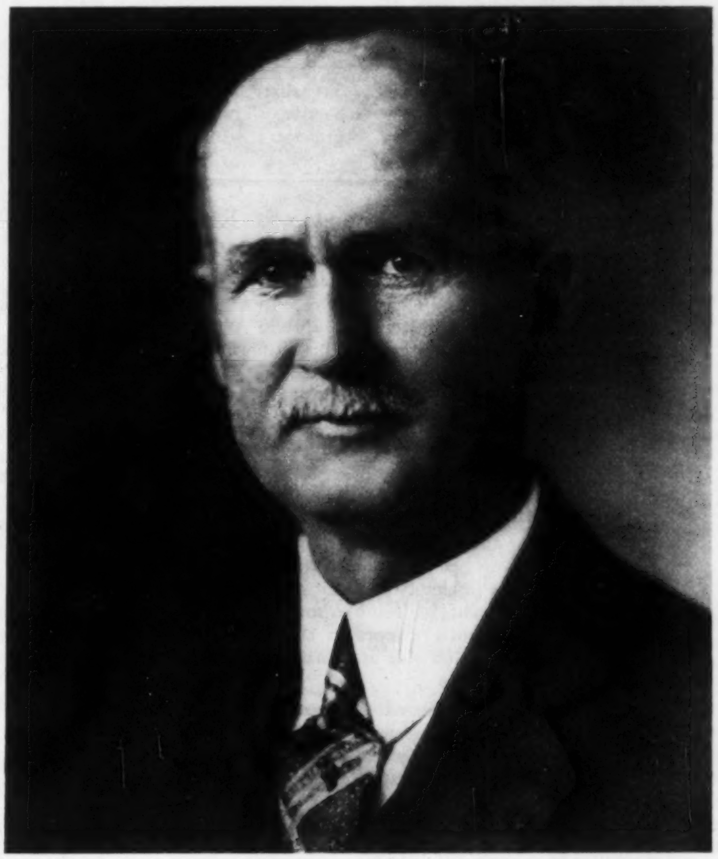
E. R. CARY, M. Am. Soc. C.E
Professor of Railroad Engineering and Highways, Rensselaer Polytechnic Institute, Troy, N.Y.

Columbia, S.C.
January 4, 1933

SOCIETY AFFAIRS

Official and Semi-Official

Our Sixty-Fourth President



ALONZO J. HAMMOND
President American Society of Civil Engineers

IT IS PARTICULARLY fitting in these days, when all organizations are necessarily disturbed, that the man selected for President of the Society during 1933 should have been connected intimately with its recent management. Alonzo John Hammond's term as Director from District 8 during the period from 1926 to 1928 was immediately followed, in 1929 and 1930, by a term as Vice-President from Zone III. Thus it is that with unusual rapidity he has taken the successive steps from directorship to presidency. Because of this fact alone he is thoroughly conversant with the Society's current program, with the projects that have been initiated during recent years, and with the problems that now clamor for solution.

Besides his experience in the preceding offices, he brings to his new honor a special fitness due to his success in many other lines of Society endeavor. For five years, 1926–1930, he served on the Society's Committee on Professional Conduct, for the last two years of this period as chairman. He was chairman of the committee which made a study of American Engineering Council in 1928. In this organization he saw the possibilities of an agency by which the public appreciation of the work of the engineer could be raised and by which technical and engineering knowledge and experience could be utilized to further the public welfare. It was upon the recommendation of this committee that the Society, in 1929, joined the American Engineering Council.

In addition, Mr. Hammond was chairman of the Functional Expansion Committee, which originated and brought into being the Functional Expansion Program. Its principles brought about the participation of the Society in problems of the present day, more particularly those pertaining to matters other than technical. To accomplish this program, a new personnel, members of the Society in different parts of the country whose qualifications particularly fitted them for the work, was appointed on committees advisory to the Board of Direction. At the Annual Meeting in 1930 the Functional Expansion Program was initiated. Committees on Local Sections, on Juniors, on Student Chapters, began to operate for the mutual good of members; other committees on Engineering Education, Public Education, Legislation, Registration of Engineers, Fees of Professional Engineers, and Salaries paid to Engineers in Public and Quasi-Public Offices came into existence and already have accomplished useful work in studying these particular problems. There yet remains much to be done, however, and it is peculiarly fitting that the affairs of the Society should be guided this year by a man whose contact with the Functional Expansion Program has been so intimate.

Born in the little community of Thorntown, near the center of Indiana, on April 23, 1869, Mr. Hammond received his early education in the public schools of Frankfort, a few miles distant. Entering Rose Polytechnic Institute in the class of 1889, he graduated with honors, and a number of years later received the professional degree of Civil Engineer. He has found time to return frequently and to give of his time to direct the affairs of his alma mater as a member of its Board of Managers.

As a young man just out of college, and after a year of postgraduate work at the Massachusetts Institute of Technology, he returned to his home town of Frankfort and opened an engineering office, engaging in architectural and municipal work, at the same time acting as City Engineer. Here he continued practice until 1898, when he was offered an opening in the office of the Chief Engineer of the Vandalia Railway in Terre Haute. South Bend, Ind., was in need of a City Engineer in 1901, and this 32-year-old assistant engineer from the Vandalia Lines was induced to accept the position. Here greater opportunities presented themselves, and in addition to the city's work of paving, sewerage, water works, and electric lighting, Mr. Hammond was sought after for the development of hydro-electric projects, suburban electric railway developments, and the building of bridges and municipal developments, both in South Bend and elsewhere.

He remained in South Bend until 1910, when the City of Chicago engaged him as consulting engineer to the Commission on City Expenditures for the purpose of reporting on the capacity of the 14-ft water tunnel at 73d Street, extending out into Lake Michigan to the "4-mile crib." This work completed, he became Chief Engineer of Chicago's Bureau of Public Efficiency. One of his important accomplishments while holding this position was a complete electrolysis survey of the water mains of the city. In 1912 he became Engineer of Bridges and Harbor in the Department of Public Works and during the following two years designed, among other important bridges, the Lake Street and the Michigan Avenue double-deck bascule bridges over the Chicago River, and built three fixed bridges by day labor.

From 1914 to 1922 he was engaged on the design and construction of the Chicago Union Station, that $75,000,000 development which gathered into one great passenger terminal the transcontinental railroad facilities of the Pennsylvania; the Chicago, Burlington and Quincy; and the Chicago, Milwaukee, and St. Paul railroads. Mr. Hammond was successively Consulting Engineer, Principal Assistant Engineer, and Assistant Chief Engineer. The work involved the solution of numerous vexing problems, such as a complete re-design of all the sewers west of the Chicago River between Kinzie Avenue and 12th Street, and the re-design of all underground utilities, including tunnels and galleries affected by the terminal tracks. Retaining walls and dock walls, track depression and construction, viaducts, and a steel and reinforced concrete bascule bridge over the river at Monroe Street, were all adjuncts to the terminal itself.

Following the termination of his work on this huge project he was appointed Chief Engineer of James O. Heyworth, Inc., and for three years was busy on the construction of a 27,000-hp hydroelectric plant on the Chippewa River in Wisconsin, of another on the Fox River in Illinois, and on the design and construction of another plant on the Mississippi River in Minnesota. During this time he built about 66 miles of highway in North Carolina and made estimates and worked out a construction program for the reinforced concrete arch over the Mississippi River at Minneapolis and St. Paul, known as the Ford Bridge.

In 1926 he became Chief Engineer of the Mellon-Stuart Company of Chicago and represented that organization in its negotiations with the Cuban Government for a $130,000,000 public improvement program for Cuba.

Since 1928 he has maintained consulting offices in Chicago for the general practice of civil engineering. He has been retained by Cedar Rapids, Iowa, on a railroad grade separation program in that city; by Sioux City, Iowa, to study and report on a railroad and river freight and passenger terminal; and by Des Moines, Iowa, to prepare preliminary sketches for a Union Passenger Terminal to be a part of the city Civic Center. He has been employed by the City of Chicago to examine and report on bids for river straightening, for dock walls, bridges, and viaducts. In Chicago he also supervised the construction of an industrial building.

Throughout this active career, Mr. Hammond has found time to devote to professional societies; he is a member of the American Institute of Consulting Engineers, the Western Society of Engineers, the American Railway Engineering Association, and the Chicago Engineers' Club. In 1905 he was president of the Indiana Engineering Society and in 1921 was president of the Illinois Section of the Society. His devotion to the work of the Society has been already recounted. He also continues his interest in the business of the City of South Bend, Ind., as Director of the Union Trust Company, of the First National Bank, and of the First Union Company.

It is typical of Mr. Hammond that whatever he finds to do he does with a will. He has the innate power to visualize a problem and carry it through to a logical conclusion. Furthermore—and what is even more important—he has the capacity to understand the "other fellow's" point of view and to harmonize divergent tendencies. These valuable traits tend not only to accomplishment but to definite progress, based on rational and helpful deductions—surely a worth-while combination of faculties, which seems especially valuable considering the needs of the day.

Blessed with a ready smile and a genial spirit, difficulties seem to evaporate in the warmth of Mr. Hammond's contact. One look at him and he commands confidence. It goes without saying that he has a host of friends, in the Board of Direction and among the membership at large, particularly those who are favored with his neighborly company. When the Society visits the Chicago World Fair this summer he will be right at home, in more ways than one. The scene of his presidential address will fittingly coincide with the site of his major engineering accomplishments.

In 1893 Mr. Hammond married Miss Flora Troll. They have two children, Mary and John. Mr. and Mrs. Hammond make their home in Evanston, Ill.

MODIFICATION OF EMERGENCY RELIEF AND CONSTRUCTION ACT RECOMMENDED

WHEREAS, The Board of Direction of the American Society of Civil Engineers is in receipt of a report from the Society's Committee on Public Works entitled "Recommended Modification in Title II of the Emergency Relief and Construction Act of 1932"; and

WHEREAS, The Board of Direction concurs with the Committee that although projects involving an aggregate expenditure of about 140 million dollars have been approved under this title, relatively few municipalities have been able to complete the arrangements necessary to enable them to obtain the money and start work; and

THAT, for the purpose of aiding the Directors of the Reconstruction Finance Corporation in making the Act more effective in the attainment of its objects, it seems desirable to modify or remove some of the restrictions, leaving these matters more in the discretion of these Directors, and otherwise to liberalize the Act, therefore be it

Resolved by the Board of Direction of the American Society of Civil Engineers, that the President and the Congress of the United States be urged to amend Title II of the Emergency Relief and Construction Act of 1932 by

(*a*) Removing the self-liquidating stipulation as applied to Section 201 (*a*) (1);

(*b*) Limiting the projects only to those which are needful and economically sound, as applied to Section 201 (*a*) (1);

(*c*) Providing that a municipality may set up such agency as may be satisfactory to the Reconstruction Finance Corporation (to regulate rents, etc., in housing projects) as applied to Section 201 (*a*) (2);

(*d*) Increasing the kinds of work devoted to the public use, which are eligible for loans under Section 201 (*a*) (3);

(*e*) Removing the restriction relative to taxation in Section 201 (*a*); and

(*f*) Reducing the interest rates on loans made under Section 201 (*a*) (1) and (2), to the lowest point consistent with the condition that the Government shall be fully reimbursed for its loan.

Adopted by the Board of Direction, January 16, 1933.

Secretary's Abstract of Executive Committee Meeting

On December 15, 1932, the Executive Committee met at Society Headquarters with President Herbert S. Crocker in the chair. Present were: George T. Seabury, Secretary; Otis E. Hovey, Treasurer; and Messrs. Chester, Coleman, Mead, Stuart, and Tuttle. The incoming President, Alonzo J. Hammond, was present by invitation.

Approval of Minutes

The minutes of the meeting of the Committee held on October 2, 1932, were approved.

Construction League of the United States

A suggested form of Prequalification Questionnaire and a suggested Code of Practice were received from the Construction League of the United States and referred to the Executive Committee of the Construction Division for report to the Board of Direction at its meeting in January.

Redistricting Zone II

Request was received from a committee of the Georgia Section to consider redistricting Zone II for improved voting distribution, and was referred to the Committee on Districts and Zones.

Joint Committee on Industrial Pollution of Streams

Authority was given to the President to appoint representatives to a Committee on Plan and Scope, jointly with the American Institute of Chemical Engineers, to plan a committee for the mutual consideration of problems incident to industrial waste disposal in its relation to water pollution.

Engineering Foundation

The President was authorized to fill vacancies among the Society's representatives on the Engineering Foundation Board, caused by the expiration of the terms of George W. Fuller and Otis E. Hovey, Members Am. Soc. C.E., in February 1933.

Share-the-Work

The 12 Banking and Industrial Committees of the Federal Reserve Districts are sponsoring a "share-the-work" campaign, and through the chairman of that activity have asked the active cooperation of the Society. The following resolution was thereupon adopted:

> WHEREAS, The unemployment situation in this country is one of the most serious problems that confronts the nation and is causing distress to millions of people, and

Whereas, The President of the United States has recommended that available work be distributed as far as possible as a means of relieving this situation and a "share-the-work" campaign is now under way under the direction of the 12 Federal Reserve District Committees for the purpose of securing the cooperation of employers and their employees in making a wider distribution of employment;

Now, therefore, be it resolved, That the Executive Committee of the American Society of Civil Engineers hereby endorses this "share-the-work" campaign.

Proposed Budget for 1933

The Budget for 1933 was prepared for presentation to the Board of Direction at its meeting in January, and other routine matters of Society business were considered and acted upon.

Final Ballot on Society Officers for 1933

33 West 39th Street
New York, N.Y.
January 11, 1933

To the Eightieth Annual Meeting
American Society of Civil Engineers:

The tellers appointed to canvass the ballot for officers of the Society for 1933 report as follows:

Total number of ballots received		3,376
Deduct:		
Ballots from members in arrears of dues	23	
Ballots not signed	72	95
Ballots canvassed		3,281
For President		
Alonzo John Hammond		3,260
Scattering		11
Blank		10
For Vice-Presidents		
Zone II:		
Frank Oliver Dufour		3,252
Scattering		8
Blank		21
Zone III:		
Frank Gilbert Jonah		3,256
Scattering		3
Blank		22
For Directors		
District No. 1 (Two to be elected)		
John Prince Hazen Perry		3,241
James Forrest Sanborn		3,252
Scattering		6
Blank for one Director		17
Blank for two Directors		23
District No. 4		
Henry John Sherman		3,265
Scattering		0
Blank		16
District No. 11		
Ralph John Reed		3,258
Scattering		0
Blank		23
District No. 14		
Wesley Winans Horner		3,255
Scattering		0
Blank		26
District No. 15		
Edward Newton Noyes		3,258
Scattering		0
Blank		23

Respectfully submitted,
Lynne J. Bevan, *Chairman*

Joseph Farhi
J. Mechanic
M. N. Quade
Martin C. Knabe
Halsey French
H. J. Alexander
R. J. Stark
Ellis E. Paul
R. M. Guerry
G. R. Heckle
T. R. Galloway
H. H. Pitcairn
Andrew Kolberk
Tellers

The Eightieth Annual Meeting

It is significant that the registration at the Eightieth Annual Meeting of the Society, in spite of the ubiquitous depression, again approached 1,800 members, students, and guests. It has continued close to this number for the past four years, a tribute to the loyalty and interest of the membership.

After two strenuous days spent by the Board of Direction in the conduct of Society business, the opening session of the Annual Meeting was called to order in the auditorium of the Engineering Societies Building by President Herbert S. Crocker at ten o'clock Wednesday morning, January 18. Both the Secretary and the Treasurer read their annual reports, which indicated the financial stability of the Society. On the platform was a galaxy of Past-Presidents, Honorary Members, and officers to do homage to the three distinguished engineers who were to receive the highest recognition within the power of the Society to bestow—that of Honorary Membership. The three who received this signal honor and the engrossed certificate that goes with it, were Lincoln Bush, Past-President Am. Soc. C.E., J. E. Greiner, and Charles L. Strobel, Members Am. Soc. C.E. In the case of Mr. Strobel the presentation was made in absentia. Biographical reviews of the careers of these three men have already appeared in Civil Engineering.

Following this ceremony, the Secretary presented to the President the winners of the Society's awards and prizes for the best papers published in Vol. 95 of Transactions, with appropriate remarks covering the papers. In an item elsewhere in this department will be found these remarks and the names of the recipients of the prizes.

Following the presentation of reports by several Standing Committees of the Society, the report of the tellers on the annual election, to be found in detail elsewhere in this department, was received and read. The 1933 officers were then declared duly elected, whereupon President-elect Alonzo J. Hammond was escorted to the platform by Robert Ridgway and Francis Lee Stuart, Past-Presidents Am. Soc. C.E., and installed as the Society's chief executive for the coming year. Replying with a short but forceful speech, he presented to retiring President Crocker the gavel with which he had exercised his authority during 1932. A silver band had been suitably engraved and attached to the gavel.

At the luncheon held on the fifth floor of the Engineering Societies Building, nearly 400 members had their first opportunity to seek out their friends and acquaintances from far and near, to meet new faces, and to discuss problems of mutual interest. The informal manner of serving the luncheon was a contributing factor in making this occasion a real success, and the hour and a half allotted to refreshments and conversation came to a close all too soon.

The afternoon session was devoted to a well received symposium on economic problems of today. David Friday, noted economist, made a plea for planning our nation's future. "We want the benefits of change, but we should like to mitigate its costs, especially those which present themselves in the form of industrial depression," he said. Fred I. Kent, New York banker, analyzed in a masterly way the causes of the depression, covering the period since the close of the World War, and discussed their significance in international relations. R. E. Dougherty, M. Am. Soc. C.E., bespoke the complete cooperation of all sections of the country and all forms of industry in solving the problems confronting the railroads.

A brilliant affair was Wednesday evening's entertainment, which took the form of a formal dinner and dance in the Roosevelt Hotel ballroom, where tables were set for 260. After the excellent dinner had been flawlessly served and duly enjoyed, the orchestra drew couple after couple on to the dance floor. The dancing continued until an unnamed hour.

All day Thursday concurrent sessions of six of the Society's Technical Divisions were held. Each Division chairman presided over a carefully prepared program approved by the Division's Executive Committee. A mere statement of the numbers in attendance at a given session is no index of the interest shown. The quietness of the corridors except for the outbursts of applause from the various auditoriums gave convincing evidence that the Division programs had "holding power." The following estimate of the attendance at the sessions will serve as a record:

General sessions:	
Wednesday morning	350
Wednesday afternoon	300
Technical Division meetings:	
Highways	50
Structural	225
Structural-Construction (joint session)	350
Sanitary Engineering	200
City Planning	70
Waterways	90

The evening was given over to a less technical lecture of interest to any red-blooded American—the story of the famous flight to the south pole by Bernt Balchen, pilot for Admiral Richard E. Byrd. More than a thousand members and guests listened to every word of this intrepid airman, who was given a real ovation at the close of his lecture. The smoker that followed the lecture was enjoyed as this occasion always is. Coffee, sandwiches, doughnuts, and "smokes" were provided, but as usual the conversation was the main attraction.

On Thursday afternoon, 250 visiting ladies were entertained at the New York home of former President Theodore Roosevelt, where tea was served. The home is now restored to its original condition and is a museum of memorabilia of the late President. In the evening the ladies enjoyed cards at the Engineering Woman's Club as guests of the Ladies Committee.

Early Friday morning, 250 boarded a West Shore Railroad train on the New Jersey side of the Hudson on their way to West Point, about 45 miles away. This party had luncheon at the Bear Mountain Inn. Saturday was given over to the inspection of local engineering developments. A record of the members who took these trips follows:

Wards Island Sewage Treatment Plant	270
Eighth Avenue Subway	40
Westchester County parkways	50
Transatlantic Pier Terminal	70
Rockefeller Center	275
Inland Terminal No. 1 of the Port Authority	80

A Society Meeting program does not "just grow." It requires the careful coordination and planning of a large group of willing and active local members. Credit for the success of the Eightieth Annual Meeting goes to the Regional Meeting Committee, of which Arthur S. Tuttle, Vice-President for Zone I, is chairman. Charles E. Trout, M. Am. Soc. C.E., headed the local committee on detailed arrangements and Mrs. Trout directed the efforts of the ladies committee in entertaining the visiting ladies during the week. This committee was most gracious and its work was most appreciatively commented on. All who served on the arrangement committees deserved and received the gratitude of the visiting members.

Medals and Prizes Awarded

AT THE PRESENTATION of the Society's medals and prizes for excellent papers previously published in TRANSACTIONS, the recipients were grouped on the platform in the auditorium and each in turn was presented to President Crocker for the award of the prize by the Secretary. In the January issue of CIVIL ENGINEERING appeared the list of prize winners, their photographs, a short biographical sketch of each recipient, and the titles of the papers for which the medals and prizes were awarded. With the following fitting words the Secretary outlined the principal features of the papers for which the prizes were awarded:

THE J. JAMES R. CROES MEDAL

"The J. James R. Croes Medal is awarded to David L. Yarnell, Senior Drainage Engineer, Bureau of Agriculture and Engineering, U.S. Department of Agriculture, and Floyd A. Nagler, Professor of Hydraulic Engineering, University of Iowa, both Members of the Society, for their paper on 'The Effect of Turbulence on Registration of Current Meters.' This paper describes a series of experiments made in the Hydraulic Laboratory of the University of Iowa on several types of current meters for the purpose of determining the effect of turbulence, of variations in direction, and of rapid changes in the speed of flow on the registration of such meters.

"The information presented by the authors is of particular interest to hydrographers in that it enables a quantitative comparison of the effects of turbulence on the various types of current meters, and as the current meter is frequently the only available means of measuring the discharge of streams, these data will be particularly welcome to engineers engaged in hydraulic work.

"I take pleasure therefore in presenting Mr. Yarnell and Professor Nagler for the award of the J. James R. Croes Medal for their paper on 'The Effect of Turbulence on Registration of Current Meters.' "

THE THOMAS FITCH ROWLAND PRIZE

"The Thomas Fitch Rowland Prize is awarded to Clifford Allen Betts, M. Am. Soc. C.E., Engineer, U.S. Bureau of Reclamation, for his paper, 'Completion of the Moffat Tunnel of Colorado.' The Moffat Tunnel through the Rocky Mountain Continental Divide, 50 miles west of Denver, Colo., which was completed in February 1928, attracted widespread attention which gave the undertaking an unusually dramatic background. The paper by Mr. Betts outlines briefly the history of the Moffat Tunnel project and describes in detail the surveys, construction methods, geological conditions, and ventilation. It also includes an appendix of cost data.

"The object of the project was to make possible a transcontinental rail route through Denver, to ensure adequate transportation facilities for northwestern Colorado, and to provide an additional source of water supply for Denver and contiguous territory. The project is of unusual interest to engineers because at the time it was the longest railway tunnel in the Americas, 6.2 miles, and the difficulties during construction due to caving ground and inflows of water led to the development of new methods of tunneling.

"Soft ground encountered for a distance of $2^1/_2$ miles in from the west portal was the outstanding problem of the construction. The methods and machinery used to combat this obstacle, including the design of heavy timbering, steel reinforcement, concrete lining, and the use of a traveling cantilever girder, are among the tunneling developments described.

"The Society is fortunate to be able to record the complete history of this undertaking, and I take pleasure in presenting Mr. Betts for the award of the Thomas Fitch Rowland Prize for his paper on the completion of the Moffat Tunnel.' "

THE JAMES LAURIE PRIZE

"The James Laurie Prize is awarded to Earl I. Brown, M. Am Soc. C.E., Colonel, Corps of Engineers, U.S. Army, for his paper. 'The Chesapeake and Delaware Canal.' Colonel Brown has presented a history of the Chesapeake and Delaware Canal project from the years 1764 to 1927, together with a record of the construction stages of the canal.

"The Chesapeake and Delaware Canal was originally constructed during the period 1825–1829 under authority of special legislation enacted by the States of Maryland, Delaware, and Pennsylvania. As indicated by its name, this canal connects Chesapeake Bay with the Delaware River.

"The canal was taken over by the Federal Government in 1919 for the purpose of replacing it with a sea-level waterway of larger dimensions. This enlargement was made during the period 1922–1927 and involved the excavation of about 16,000,000 cu yd of earth, the construction of a number of highway bridges, and one railway bridge.

"The Society is fortunate in being able to record in its TRANSACTIONS the entire history of this project. Information given by the author is particularly valuable, in that the quantity, yardage, prices, costs, and methods of procedure in connection with the dredging operations are given in detail. A brief outline is given of the hydraulic theory applied to the project.

"I take pleasure, therefore, in presenting Colonel Brown for the award of the James Laurie Prize for his paper on 'The Chesapeake and Delaware Canal.' "

The Arthur M. Wellington Prize

"The Arthur M. Wellington Prize is awarded to Fred Lavis, M. Am. Soc. C.E., Consulting Engineer, for his paper, 'Highways as Elements of Transportation.' The theme of the paper by Mr. Lavis is that, for handling large volumes of traffic through congested areas, highways should be designed for the main purpose of transportation rather than as adjuncts of abutting property. In developing this theme, Mr. Lavis traces briefly the history of highways and the growing demand for a new type of road to meet the needs occasioned by the ever-increasing use of motor vehicles. Where congestion of existing streets interferes with the reasonable free passage of vehicles and pedestrians, highways of the type described are necessary, not only to expedite through traffic, but also to restore streets to their normal uses.

"As an illustration of a highway designed primarily to meet the demands of the users and to offer the minimum congestion to cross traffic of all kinds, the arterial highway of the State of New Jersey between the Hudson River and Elizabeth, N.J., is used as an example. At its eastern end, this highway connects with the Holland Vehicular Tunnel; thence it passes through Jersey City, and the lower part of the town of Kearny, by-passes the City of Newark, and connects with the main highway route toward the south, beyond the City of Elizabeth. For the first eight miles there are no crossings of other highways at grade.

"In presenting the various economic factors that were considered in the design of this highway, the paper has the merit of avoiding extended mathematical processes. An outline of their application to a part of the route is given as a guide to those who have similar problems. The paper, therefore, is an important one in highway literature, and the Society is pleased to recognize its worth in the award of the Wellington Prize to its author.

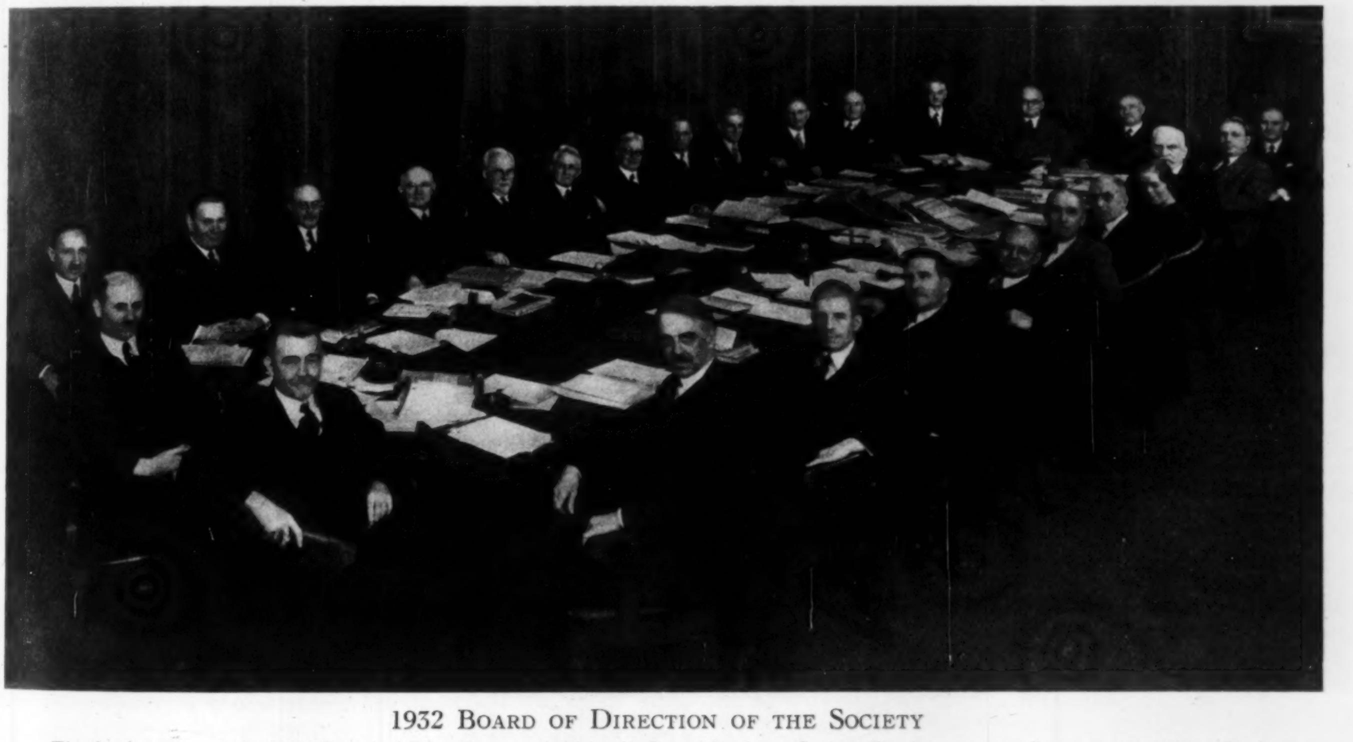
"I take pleasure, therefore, in presenting Mr. Lavis for the award of the Arthur M. Wellington Prize for his paper on 'Highways as Elements of Transportation.' "

The Collingwood Prize for Juniors

"The Collingwood Prize for Juniors is awarded to A. R. C. Markl, Assoc. M. Am. Soc. C.E., for his paper, 'The Shannon Power Development in the Irish Free State.' Mr. Markl in his paper has described one of the foremost projects of the Irish Free State Government for the development of the country. The Shannon Power Development is designed to supply a maximum of 500,000,000 kwhr when fully completed.

"Another remarkable feature of the development was the equipment and the methods used in the building of the head-race of the plant, which differed from American practice and were without precedent in Europe. On account of the scarcity of native labor skilled in construction work, and the very rainy climate, it was necessary to use machinery everywhere possible in order to complete the work in reasonable time. The author believes that a new method for building large embankments was developed that is particularly adapted to work involving great longitudinal extension. While the machinery was mainly intended for handling light soil, it proved economical under severe conditions in wet and viscous material, and in a climate unfavorable to outdoor construction work. These conclusions are reflected in the low price at which the work was done. The Society's appraisal of the value of this paper, which describes so completely another advancement in the progress and art of engineering, is attested in the award of the Collingwood Prize to Mr. Markl.

"I take pleasure, therefore, in presenting Mr. Markl for the award of the Collingwood Prize for Juniors for his paper on 'The Shannon Power Development in the Irish Free State.' "



1932 Board of Direction of the Society

The final session of the 1932 Board of Direction was held in the Board Room at Society Headquarters on January 17, 1933. Beginning at the left of the nearest corner of the table and proceeding around in a clockwise direction, those present were: (1) J. F. Coleman, Past-President; (2) Ole Singstad, Director, District 1; (3) Robert Hoffmann, Director, District 9; (4) E. B. Black, Director, District 16; (5) D. A. MacCrea, Director, District 14; (6) J. N. Chester, Vice-President, Zone II; (7) Charles A. Mead, Director, District 1; (8) E. K. Morse, Director, District 6; (9) Arthur S. Tuttle, Vice-President, Zone I; (10) John H. Gregory, Director, District 5; (11) Charles H. Stevens, Director, District 4; (12) H. D. Mendenhall, Director, District 10; (13) Edward P. Lupfer, Director, District 3; (14) F. C. Herrmann Director, District 13; (15) Henry E. Riggs, Director, District 7; (16) Francis Lee Stuart, Past-President; (17) Franklin Thomas, Director, District 11; (18) M. L. Enger, Director, District 8; (19) Otis E. Hovey, Treasurer; (20) Carolina Crook, Secretary to Mr. Seabury; (21) George T. Seabury, Secretary; (22) Herbert S. Crocker, President; (23) Allan T. Dusenbury, Director, District 15; (24) J. C. Stevens, Director, District 12; (25) L. G. Holleran, Director, District 1; (26) Henry R. Buck, Director, District 2. Absent: D. C. Henny, Vice-President, Zone IV; H. M. Waite, Vice-President, Zone III; and John R. Slattery (deceased), Director, District 1.

Are Engineers Through at Forty?

By ARTHUR RICHARDS, M. AM. SOC. C.E.

MEMBER OF THE SOCIETY'S COMMITTEE ON SALARIES OF ENGINEERS IN PUBLIC AND QUASI-PUBLIC OFFICES

FEELING that civil engineers and the municipalities or corporations by which they are employed should have definite knowledge of the classifications of responsibility and the equitable compensation that properly should go with them, the Board of Direction, early in 1927, appointed a committee to study the salaries of engineers in public and quasi-public offices. Since that time a wealth of data has been collected; questionnaires have been sent out and returned; tables of organization have been studied; and an immense amount of work has been done by the committee in reducing the results to a common basis for comparison and in analyzing them. One of the products of the analysis is contained in the following brief article by Mr. Richards, member of the committee, who has made the analysis he sets forth and prepared the accompanying diagrams.

MANY times it has been claimed that after men reach the age of 40, their services are not in great demand. But the 1930 census entirely disproves this claim, especially as regards the members of the engineering profession. In fact, it can be readily proved that at the age of 40 the engineer is really starting out on the most interesting and active period of his professional career.

The data used in the preparation of the accompanying curves are taken from the 1930 census returns, and from a report on classification and compensation of civil engineering positions in preparation by the Society's Committee on Salaries of Engineers in Public and Quasi-Public Offices.

The engineering profession is numerically larger in membership than several other professions, as the census shows the following distribution:

Architecture	24,057
Law	157,220
Medicine	221,300
Engineering	224,956

In Fig. 1 is shown the rate of growth in the number of technical engineers in the United States between the years 1920 and 1930. The engineers are divided into four main groups—civil, mechanical, electrical, and mining. Draftsmen are shown, but are not counted in the totals for each census. Designers are not included. This chart indicates that the total number of engineers increased from 136,121 in 1920, to 226,249 in 1930, an increase of 66 per cent; that the civil engineers increased 58 per cent; the mechanical, 44 per cent; the electrical, 113 per cent; and the mining engineers, 79 per cent. In the 1910–1920 decade, the total increase was 53 per cent, that for civil engineers being 24 per cent; that for mechanical, 159; and that for electrical, 77 per cent; while in the case of mining engineers there was a decrease of 1 per cent.

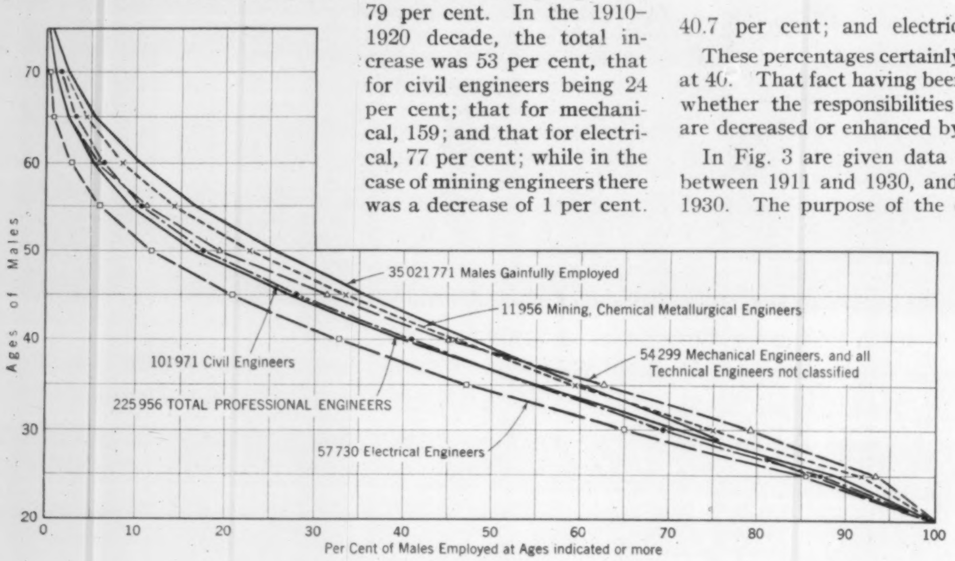


FIG. 2. RELATIVE AGES OF MALES OVER TWENTY GAINFULLY EMPLOYED
According to the 1930 Census

It is interesting to note that while the members of the engineering profession increased 66 per cent during the past census decade, the total population of the United States increased only 16.1 per cent, the male population, 15.3 per cent, and the males gainfully employed, 15.2 per cent. The query naturally arises, "Is the profession overcrowded?" An analysis of the subject would no doubt bring out some interesting information.

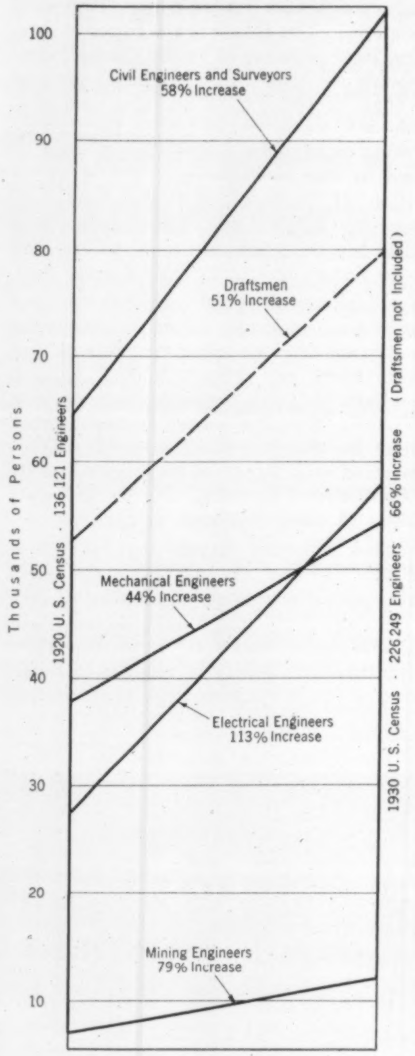


FIG. 1. GROWTH IN NUMBER OF ENGINEERS

In the United States, 1920–1930

In Fig. 2 is given the number of employed males and professional engineers over 20 years of age in 1930, in relation to their ages. The chart is read as follows: in 1930, 50 per cent of the 35,031,771 males gainfully employed in the United States were 20 or more years of age, while 50 per cent of the 225,956 professional engineers were 35½ or more years old.

It is of interest to observe what the chart contains in regard to the previously mentioned "dead-line" age of 40. Of all the employed males over 20 years of age, 47.5 per cent were 40 years of age or older, while the percentage for the professional engineers was 40.2. In the branches of the profession the following percentages apply: mining, 45.6 per cent; mechanical, 45.7 per cent; civil, 40.7 per cent; and electrical, 32.8 per cent.

These percentages certainly do not indicate that a man is through at 40. That fact having been proved, it will be of concern to know whether the responsibilities and earning capacities of engineers are decreased or enhanced by age.

In Fig. 3 are given data on 12,322 positions of chief engineer between 1911 and 1930, and on 1,085 chief engineers in the year 1930. The purpose of the diagram is to show the age curve of chief engineers and the number of positions held by them at various ages. The chart contains two sets of curves. The lower part of the chart, containing the curves marked *A* and *B*, is read as follows: 50 per cent of the 12,322 chief engineers between 1911 and 1930 were 42 or more years of age, and 50 per cent of the 1,085 chief engineers in 1930 were 45 or more years old. The upper part of the chart, containing Curves *C* and *D*, indicates the number of positions held at the various ages, and shows that between 1911 and 1930 the greatest number of chief engineers were

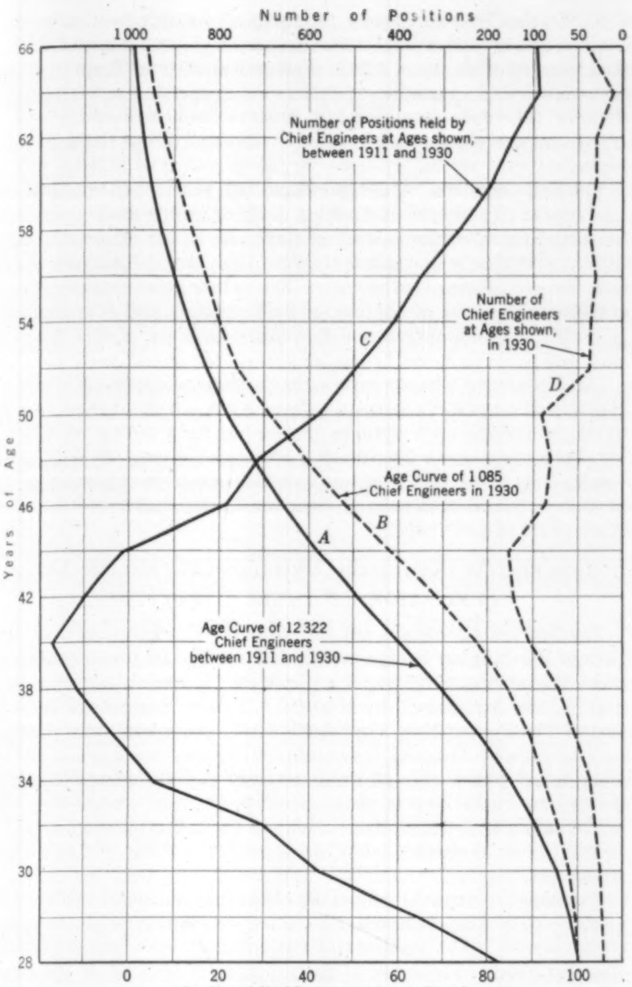


Fig. 3. Curve of Age and Number of Positions Held, for Chief Engineers
Average Age of This Group Is Increasing

aged 40, and that in 1930 the largest number were aged 44.

A comparison of Curves *A* and *B* indicates that during the past 20 years the ages of chief engineers have increased. Curve *A* shows that 42 per cent were 44 or more years old, while Curve *B* shows that 58 per cent were that age. It is of interest to note that, although Curve *C* indicates that the greatest number of the engineers were aged 40, there were more engineers aged 44 than 34, and that there were as many aged 50 as there were aged 30. Curve *D* shows there were as many chief engineers for each year of age between 52 and 62 as there were for the age 34. In other words, age is an asset in the profession of engineering.

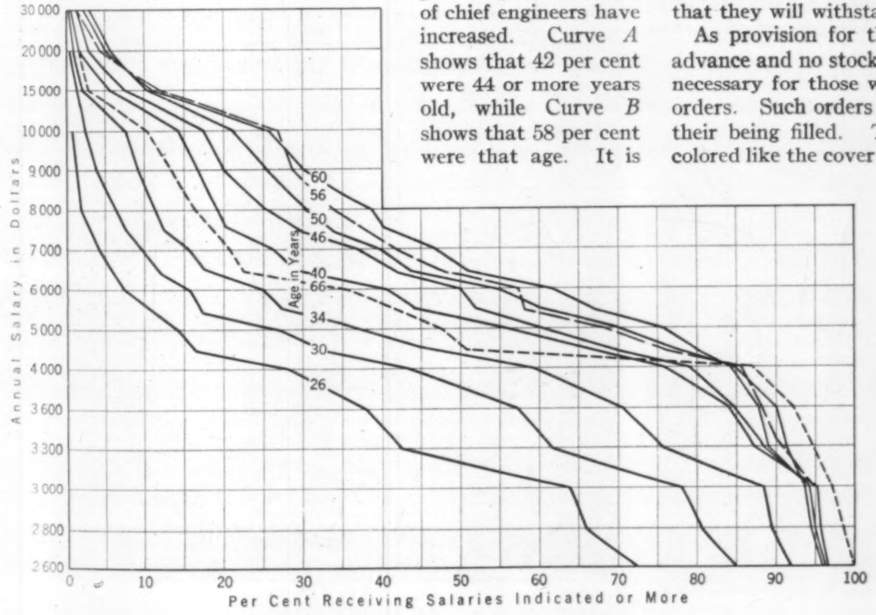


Fig. 4. Salaries in Relation to Age
For 12,322 Chief Engineers in the Civil Engineering Branch, 1911–1930. Note Continuous Increase up to Age Sixty

This is further proved by reference to Fig. 4, which indicates the salaries received in the 12,322 positions of chief engineer between the years 1911 and 1930. It is clearly apparent that salaries increase to the age of 60 in these positions, and then begin a decline to the age of 66 or more. The curves are read as follows: 50 per cent of the 12,322 chief engineers at the age of 30 received an annual salary of $3,800 or more; at the age of 40, the same percentage received $5,200 or more; at the age of 50, they received $6,200 or more; at the age of 60, $6,600 or more; and at the age of 66, $4,600 or more.

The 66-year curve may be taken as equivalent to a 38-year curve, and this would mean that for 26 years after the chief engineers reached the age of 40 they received higher compensation than they had received when they were 40. If these 66-year-old engineers graduated at the age of 22, then they served only 18 years before they reached 40, but after that time they served 26 years. Certainly this chart does not indicate that the engineer has finished his active career when only 40 years of age.

The data here shown are worthy of serious consideration by members of the engineering profession, and of passing on to the public. It is apparently a wise investment to employ engineers over 40 in responsible positions, because then the employer can be assured of securing the most productive and efficient years of the engineer's career in specialized knowledge and service.

Year Book Available in Cloth Binding

The Society *Year Book*, which is furnished to every member, is designed for moderate but not excessive use, in so far as its physical form is concerned. That is, in general the cardboard covers have ample strength to withstand the ordinary usage of the average member without serious damage or wear.

In special cases, however, excessive use is to be expected. Local Section officials, for example, may find it necessary to make continuous reference to the *Year Book*. Other members may consult it frequently for statistics and regulations, in addition to addresses. Such excessive use is beyond the capacity for which the cardboard covers are designed, and therefore it has been suggested that in special cases members may wish to obtain a copy bound in cloth. Experience with a few of these in use at Headquarters indicates that they will withstand almost any amount of handling.

As provision for the special cloth binding has to be made in advance and no stock for general supply is kept on hand, it will be necessary for those who desire it to notify Headquarters of their orders. Such orders should be received by February 20 to ensure their being filled. The charge for the special binding, in cloth colored like the cover of the regular issue, will be $1.00.

Society Appointees

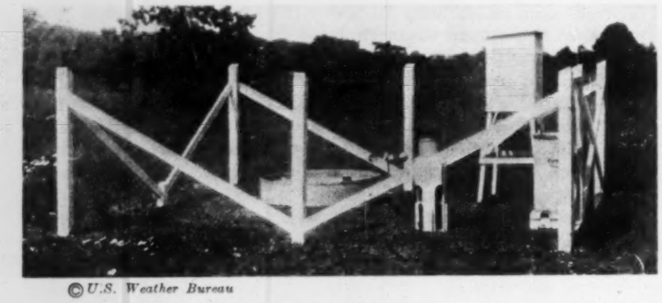
George W. Fuller, M. Am. Soc. C.E., Chairman; and C. McK. Everett, H. H. Hatch, D. C. Henny, F. C. Herrmann, Joel D. Justin, Thaddeus Merriman, Charles H. Paul, and Raymond F. Walter, Members Am. Soc. C.E., have been appointed a committee to study the advisability of instituting a later "Committee on Tests of Materials for Hydraulic Fill Dams."

A. J. Hammond, President Am. Soc. C.E.; Herbert S. Crocker, Past-President Am. Soc. C.E.; and Lewis M. Gram and Frank A. Randall, Members Am. Soc. C.E., have been appointed to represent the Society in the Assembly of the Construction League of the United States.

A Preview of Proceedings

The February issue of PROCEEDINGS, *to be mailed on February 15, is to contain two symposiums of widely different import. The first, on evaporation, contains three short papers, each on a different phase of evaporation from water surfaces. The second symposium closes the series of papers that have been appearing in* PROCEEDINGS *on the George Washington Bridge over the Hudson River at New York.*

SYMPOSIUM: EVAPORATION FROM WATER SURFACES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U.S. WEATHER BUREAU CLASS A EVAPORATION STATION

THREE CONTRIBUTIONS on the subject of evaporation have been grouped to form a symposium. The first of the group, "Evaporation from Different Types of Pans," was first presented by Carl Rohwer, Assoc. M. Am. Soc. C.E., and was accepted for publication as a separate paper.

Subsequently a committee report, "Standard Equipment for Evaporation Stations," the final report of the Subcommittee on Evaporation of the Society's Special Committee on Irrigation Hydraulics, and a paper, "Evaporation from Reservoir Surfaces," by Robert Follansbee, M. Am. Soc. C.E., were accepted and the present arrangement devised. The intention is to direct discussion into three distinct channels: pan evaporation, reservoir evaporation, and evaporation equipment.

In preparing his paper, Mr. Rohwer was concerned primarily with the task of collating and interpreting all available data on evaporation from pans varying from 1 to 85 ft in diameter, and with some incidental comparisons of evaporation from reservoirs. The evaporation equipment treated in the paper consists of land pans and floating pans, square pans and circular pans, sunken pans and exposed pans. The advantages and disadvantages of each are discussed.

When all factors are considered, according to Mr. Rohwer, the U.S Weather Bureau Class A land pan is probably best suited for evaporation investigations. The accompanying photograph is of a station using such a pan 4 ft in diameter and 10 in. deep. In the enclosure are an anemometer, an 8-in. rain gage, and an instrument shelter. The data on which Mr. Rohwer's conclusions are based, are arranged in the form of six tables in an appendix at the end of his paper.

The Subcommittee on Evaporation Equipment has confined its final report to a simple declaration of its recommended equipment for evaporation stations, lending emphasis to Mr. Rohwer's conclusion that if only one pan is feasible, the Class A land pan of the U.S. Weather Bureau is the best. The subcommittee presents two arguments in favor of the use of floating pans and four against. It names six advantages and two disadvantages of the Class A land pan.

Mr. Follansbee's paper serves the purpose of applying the findings regarding pan evaporation to reservoirs. A great mass of material, comprising 200 or more tables, has been placed on file by Mr. Follansbee in the Engineering Societies Library, 29 West 39th Street, New York, N.Y. These records contain data pertaining to evaporation from reservoirs all over the United States and in many other parts of the world.

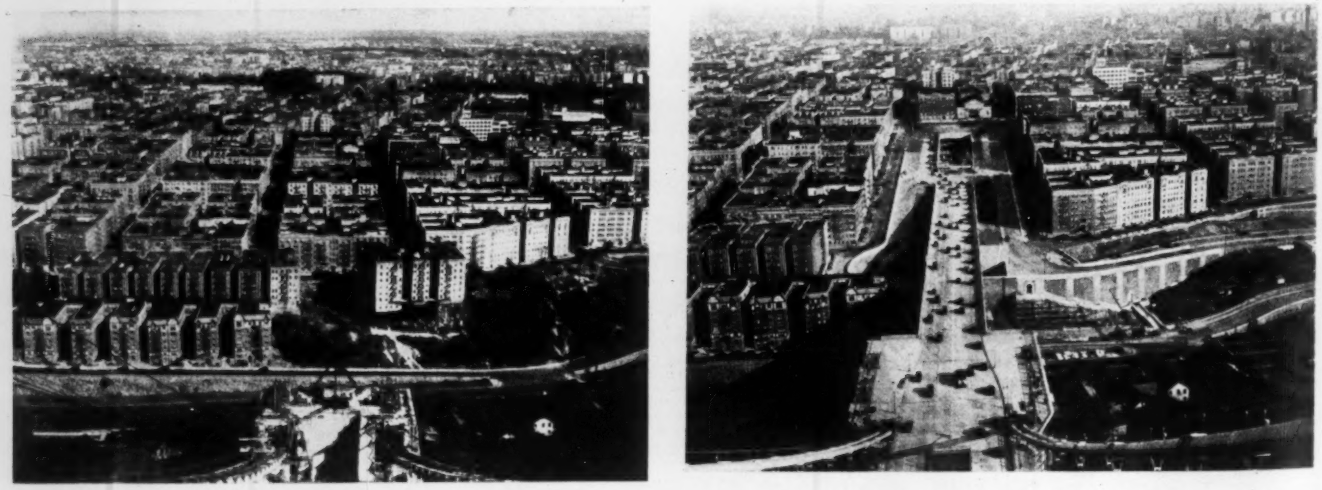
GEORGE WASHINGTON BRIDGE—MATERIALS AND FABRICATION OF STEEL STRUCTURE

THE SERIES OF PAPERS on the design and construction of the George Washington Bridge is rounded out by the presentation, in this issue of PROCEEDINGS, of a paper on "Materials and Fabrication of Steel Structure," by Herbert J. Baker, Engineer of Inspection of The Port of New York Authority. Approximately 100,000 tons of metallic materials were required in the construction of the main bridge structure. Of these, roughly 43,000 tons were used in the towers, 19,000 tons in the suspended structure, and 31,000 tons in the cables and suspenders. None of the materials used were of an experimental nature, as all had been successfully used in bridge structures.

The paper records the properties of the materials and outlines the method of testing followed to ensure conformity with specified requirements. The methods of manufacture and fabrication are also described. These are of special interest because of the large quantities of material involved and because of the unusual size of the members. The shaping of the cable grooves in the eight main-tower saddles was accomplished by milling machines traveling on a curved track.

GEORGE WASHINGTON BRIDGE—APPROACHES AND HIGHWAY CONNECTIONS

"APPROACHES AND HIGHWAY CONNECTIONS" is the subject of the last paper of the series on the design and construction of the George Washington Bridge. The paper is presented by J. C. Evans, Terminal Engineer of The Port of New York Authority,



NEW YORK APPROACH TO THE GEORGE WASHINGTON BRIDGE

Views from Top of New York Tower. Left, Before Clearing Away Existing Improvements; Right, After Completion of Approach Roadway Construction who was in charge of the planning of the approaches. The approaches are considered as major elements of the bridge project, for they must be able to distribute traffic adequately in order that the main bridge structure may fulfill its purpose. The broad viewpoint of the Port Authority in the development of the plans is shown; the approaches were considered to embrace not merely the ramps leading from the bridge proper to wherever they strike the ground, but were held to include adequate connections between the ramps and existing through-traffic arteries.

Development of the plans in cooperation with representatives of the municipal, county, and state governments is described. The conditions met with at the two ends of the bridge were radically different. In Manhattan the approaches are located in a highly congested area, as is shown by the accompanying photographs, while in New Jersey they are in suburban territory.

The paper describes the approach plans, the criteria governing their development, and the arrangement whereby the Manhattan approach was built in an initial stage, the final stage to be completed later. Space is also given to a brief description of traffic-indicating and toll-collection equipment, much of which was specially designed for use on this and other Port Authority projects.

News of Local Sections

ALABAMA SECTION

The annual meeting of the Alabama Section was held at the University of Alabama, Tuscaloosa, on December 2. The election of officers for 1933, which took place at this time, resulted as follows: George J. Davis, Jr., President; H. H. Houk, First Vice-President; W. N. Woodbury, Second Vice-President; and D. C. A. du Plantier, Secretary-Treasurer. A program of entertainment, consisting of various interesting features, was then presented by members of the University of Alabama Student Chapter, which was the guest of the Section for the occasion.

CENTRAL OHIO SECTION

There were 33 in attendance at the regular monthly meeting of the Central Ohio Section, held in Columbus on December 22. After the usual business session, Prof. John Younger, of the Ohio State University, gave an interesting talk on "Technocracy." A general discussion of this subject then followed.

CHATTANOOGA SECTION

At the annual meeting of the Chattanooga Section, held on December 13, officers for 1933 were elected as follows: Clifford A. Betts, President; Joseph Wright, First Vice-President; L. B. Feagin, Second Vice-President; and F. C. French, Secretary-Treasurer.

CINCINNATI SECTION

Various phases of the design and construction of the new Cincinnati Times-Star Building were brought out in the addresses given before the meeting of the Cincinnati Section, held on December 13. Those who spoke were Waldemar Lensky, Charles T. Kennedy, Walter Farrell, and Fred W. Morrill. Prior to the meeting, the members had been conducted on an inspection trip through the printing plant, and dinner had been served by a caterer in the building. There were 65 present at the meeting.

DAYTON SECTION

There were 18 in attendance at the regular monthly meeting of the Dayton Section, held at the Engineers Club on November 21. The feature of the occasion was a talk given by William Haas, President of the William Haas Company, who spoke on conditions in Europe. Mr. Haas has recently returned from an extended trip abroad.

On December 19, the annual meeting of the Section was held at the Engineers Club, with 24 in attendance. The election of officers for 1933 resulted as follows: George F. Baker, President; W. E. Keyser, Second Vice-President; and John F. Hale, Secretary-Treasurer. Robert B. Prinz, Second Vice-President for 1932, automatically becomes First Vice-President for 1933. Through the courtesy of H. E. Senf, of the American Rolling Mills, Middletown, Ohio, a program on the metal frame house was presented by Hugh Wright, of the Ohio Corrugated Culvert Company.

FLORIDA SECTION

At the annual meeting of the Florida Section, the following officers for 1933 were elected: C. C. Brown, President; and W. W. Fineren, Secretary-Treasurer.

GEORGIA SECTION

There were 23 in attendance at the regular meeting of the Georgia Section, held at the Atlanta Athletic Club, Atlanta, on November 7. An interesting and practical talk was given by James A. Perry, Chairman of the Georgia Public Service Commission, who spoke on "The Engineer as an Expert Witness." In his talk, Mr. Perry emphasized the need for the passage of a law enforcing the proper registration of engineers in order to raise the standards of engineering practice in the state.

ILLINOIS SECTION

Results of the annual election of officers for the Illinois Section, held on December 12, are as follows: W. W. DeBerard, President; A. W. Newton, Vice-President; and C. W. Haupt, Treasurer.

ITHACA SECTION

Representatives from all four Local Sections within District No. 3 were present at a joint meeting of the Ithaca Section and the Cornell University Student Chapter, held on November 21. Guests included the following: from the Buffalo Section, Nathan H. Sturdy, president, and S. Townsend Carpenter, former president; from the Syracuse Section, Frank W. Stephens, president, and Glenn D. Holmes; and from the Rochester Section, C. C. Cooman, vice-president, and John F. Skinner. Dinner at the Willard Straight Hall preceded the meeting, which was held in Sibley Hall on the campus of Cornell University. The guest of honor was Edward P. Lupfer, Society Director from District No. 3, who discussed various Society affairs of interest to the membership and then spoke on the subject of "Early Transportation Between the Mississippi River and the Pacific Coast."

On December 5, the Ithaca Section held a dinner meeting in Willard Straight Hall on the campus of Cornell University. After dinner Dean Kimball, of the university, briefly addressed the group. This was followed by a lecture on "Trends in Building Construction and Structural Design," given by H. V. Spurr, Chief Engineer for the Purdy and Henderson Company, of New York, N.Y. The meeting was well attended and drew members from the Syracuse Section.

At its meeting on January 5, the Section elected officers for 1933 as follows: Henry W. Preston, President; and Fred Asa Barnes, Second Vice-President. The terms of the other two officers will not expire until October 1933.

KANSAS CITY SECTION

At a meeting of the Kansas City Section, held on December 16, the following officers were elected to serve during 1933: T. J. Strickler, President; R. W. Waddell and O. A. Zimmerman, Vice-Presidents; and C. S. Heritage, Secretary-Treasurer.

LEHIGH VALLEY SECTION

The tenth annual meeting of the Lehigh Valley Section was held in December. The Publication Committee, headed by H. T. Rights, presented its report in the form of a booklet commemorating the tenth anniversary of the Section. This booklet contains a list of past officers, speakers at past meetings, and a list of present members with a brief summary of their experience. Grover C. Brown, chairman of the Membership Committee, gave a very interesting report covering the past ten years of membership in the Local Section.

President H. S. Crocker and Secretary Seabury were present at the dinner-meeting and gave very instructive talks on current Society work.

The officers elected for the year were as follows: Lynn Perry, President; H. G. Payrow and H. T. Rights, Vice-Presidents; and M. O. Fuller, Secretary-Treasurer.

LOS ANGELES SECTION

The unfamiliar atmosphere of a motion picture studio was the scene of the January 11 meeting of the Los Angeles Section, which was attended by nearly 300. The program was arranged through the cooperation of the Academy of Motion Picture Arts and Sciences and the courtesy of Warner Brothers First National Studios. Among those who spoke were: Maj. Nathan Levinson, Director of Sound for Warner Brothers; J. A. Ball, Technical Director for Technicolor Motion Picture Corporation; and Max Parker, Art Director of Fox Film Corporation.

METROPOLITAN SECTION

Parkways and main traffic routes formed the topic for discussion at the regular January meeting of the Metropolitan Section, held in the Engineering Societies Building in New York, on January 11. Jay Downer, speaking from the vantage point of his position as Chief Engineer of the Westchester County Park Commission as well as County Engineer, gave an interesting description of the chief features of that famous park system and the lessons learned in its development. A particularly fine set of lantern slides illustrated his talk. Brief discussion was offered by Fred Lavis, after which the meeting adjourned for refreshments. It was announced during the meeting that the Section had augmented a gift of $1,000 for the past year's activity of the Professional Engineers Committee on Unemployment by one of $500 for the current year. The attendance was about 225.

PANAMA SECTION

At the annual meeting of the Panama Section, held on December 12, the following officers for 1933 were elected: Leopoldo Arosemena, President; E. S. Randolph, First Vice-President; B. J. Fletcher, Second Vice-President; and L. B. Moore, Secretary-Treasurer.

PHILADELPHIA SECTION

A joint dinner meeting of the Philadelphia Section and the Engineers' Club was held on December 20. There were 73 present at the dinner and 156 at the meeting. Charles Gordon, managing director of the American Transit Association, was the principal speaker. In his talk he reviewed the many serious problems of urban transportation and emphasized the difficulties confronting the street railway companies today. Among those who participated in a spirited discussion of the subject were: Dr. Thomas Conway, a professor at the University of Pennsylvania; C. O. Guernsey, Chief Engineer of the J. G. Brill Company; and H. S. Murphy, assistant to the operating vice-president of the Philadelphia Rapid Transit Company.

PORTLAND (ORE.) SECTION

There were 39 in attendance at a meeting of the Portland (Ore.) Section, held on December 15. After the routine business session, the speaker of the evening, Charles A. Mockmore, Professor of Engineering at Oregon State College, at Corvallis, was introduced. His address, which was illustrated by several lantern slides and four reels of motion pictures, dealt with experimental work on models of dams, sluice gates, and baffle piers under the action of flowing water. These tests were conducted for the U.S. Army Engineers at the Iowa State College Hydraulic Laboratory. After the meeting, a buffet supper and social hour were enjoyed by those present.

PUERTO RICO SECTION

The annual meeting of the Puerto Rico Section was held on December 13 in the assembly hall of the American Railroad Company of Puerto Rico, at San Juan. Election of officers for 1933 resulted as follows: Manuel Font, President; Antonio Lucchetti and Eoline R. Hand, Vice-Presidents; and Reinaldo Ramirez, Secretary-Treasurer. After the business meeting, two technical papers—one on hurricanes and the other on wood preservation—were read.

SAN FRANCISCO SECTION

There were 145 members and guests present at a meeting of the San Francisco Section, held at the Engineers' Club on October 18. Owing to the illness of Allard A. Calkins, San Francisco manager of the Loan Agency of the Reconstruction Finance Corporation, who was to have been the first speaker, J. S. McCullough, Jr., acting manager of the San Francisco Loan Agency of the same corporation, was present to deliver his address. The other speaker was E. J. Schneider, contracting manager of the Bridge and Structural Department of the Columbia Steel Company and vice-chairman for northern California of the National Committee for Trade Recovery.

SEATTLE SECTION

The regular monthly meeting of the Seattle Section was held on December 27, with 24 in attendance. Following dinner and the business session, Clark Eldridge, Bridge Engineer for the City of Seattle, gave an illustrated lecture on the subject of the "New University Bridge." Then John A. Dunford, Bridge Maintenance Engineer for the city, gave an account of the reconstruction of the University bascule bridge. He also illustrated his remarks with lantern slides.

SPOKANE SECTION

At a noon meeting of the Spokane Section, held at the Davenport Hotel on December 9, the following officers for 1933 were elected: Ivan C. Crawford, President; E. H. Collins, First Vice-President; B. J. Garnett, Second Vice-President; and J. Walter Robinson, Secretary-Treasurer.

ST. LOUIS SECTION

Approximately 40 members and guests of the St. Louis Section attended the regular monthly meeting, held at the Hotel Mayfair on November 28. Officers for 1933 were elected as follows: L. R. Bowen, President; Francis T. Cutts and H. Austill, Vice-Presidents; and R. A. Willis, Secretary-Treasurer.

TACOMA SECTION

On September 13, S. Nelson, naval architect, spoke before a meeting of the Tacoma Section on the subject of "Aerodynamics of Sails." Dr. Hopkins, U.S. biologist at Olympia, addressed a meeting of the Section, held on October 10, on the oyster industry of Puget Sound. And at the meeting held on November 14, W. E. Priestly, of Seattle, was the speaker. His subject was "Business Methods and Conditions in the Orient."

At the meeting held on December 12, officers for 1933 were elected as follows: Walter J. Ryan, President; Glenn L. Parker, Vice-President; and Julian Arntson, Secretary-Treasurer. The speaker of the evening was E. M. Chandler, Consulting Engineer of Olympia, who spoke on the technical features of design of the proposed Narrows Bridge west of Tacoma.

Student Chapter News

COLLEGE OF THE CITY OF NEW YORK

Several interesting lectures have been enjoyed by the College of the City of New York Student Chapter. On October 27, George E. Barnes, an engineer in the New York City Department of Sanitation, spoke on "The Wards Island Sewage Treatment Plant." On November 10, P. L. Gerhardt, industrial consultant for the Port of New York Authority, addressed a gathering on the subject, "Inland Terminal No. 1"; and on December 1, Dr. D. B. Steinman, consulting engineer, spoke on "Advancing the Status of the Engineering Profession." The semi-annual initiation and dinner took place on November 23, when 20 new members were welcomed into the Chapter.

NEW YORK UNIVERSITY

At the November meeting of the New York University Student Chapter, Robert W. Armstrong, Senior Division Engineer of the Board of Water Supply of the City of New York, gave an interesting illustrated lecture. His subject was construction in general and, in particular, the city's new $43,000,000 water tunnel.

Fifty Years and More

In November 1932, the Society reached the age of 80 years. No member can boast of any such period of membership, yet this mark is approached by Professors Burr and Fletcher, both of whom were accepted for membership in 1874—59 years ago. Recent delving into statistics at Headquarters reveals that there are now 26 members whose affiliations with the Society have extended over a period of half a century. The names of the members of this distinguished group follow:

William Hubert Burr	Jun., June 1874; Affiliate, May 1880; M., Mar. 1886
Robert Fletcher	Affiliate, Nov. 1874; M., Aug. 1909
Charles Penrose Perkins	Jun., Feb. 1875; M., Apr. 1882
Frederick Billings Howard	Jun., Mar. 1875; M., Nov. 1878
Caspar Wistar Haines	Jun., Feb. 1876; M., Oct. 1891
Henry Newton Francis	Jun., Mar. 1876; M., Nov. 1888
Charles Emery Billin	Jun., Apr. 1876; M., July 1878
Frank Ormond Whitney	Jun., May 1876; M., Jan. 1887
Charles R. Flint	Fellow, June 1876
William Covington Gunnell	M., Feb. 1877
C. Frank Allen	M., Feb. 1878
Percival Roberts, Jr.	Affiliate, May 1879; M., June 1884
Charles Louis Strobel	M., Dec. 1879; Hon. M., Oct. 1932
George Herndon Pegram	Jun., Apr. 1880; M., Jan. 1883; Hon. M., Oct. 1931
Samuel Humphreys Yonge	M., May 1880
George Hume Simpson	M., Oct. 1880
John William Ferguson	Jun., Jan. 1881; M., Feb. 1887
Sidney Francis Lewis	M., May 1881
Walter A. Doane	M., Sept. 1881
John Alexander Low Waddell	M., Oct. 1881
Onward Bates	M., Jan. 1882; Hon. M., Oct. 1923
Gustav Lindenthal	M., May 1882; Hon. M., Oct. 1929
John Francis LeBaron	M., June 1882
George Edward Thackray	Jun., Sept. 1882; M., Apr. 1886
Russell Thayer	M., Dec. 1882
Charles F. Loweth	Jun., Jan. 1883; M., Feb. 1884

A similar list was published in Civil Engineering a year ago. Since that time some changes have appeared in the personnel of this group. It has lost two members by death and gained five who have since become 50-year members. It is to be noted that Charles L. Strobel has now become an Honorary Member of the Society and that George H. Pegram, Past-President and Honorary Member, this year celebrates the 50th anniversary of his advancement to the grade of Member of the Society.

American Engineering Council

National representative of 26 engineering societies, with a constituent membership of 60,000 professional engineers, reports civil engineering news of the Federal Government

Second Session, 72nd Congress

Since the opening of the second session of the 72nd Congress, there has been a steady stream of bills introduced for the consideration of that body. Many of these bills are of engineering interest. Of vital interest to the profession at this particular time are the efforts which are being made to amend the Emergency Relief and Construction Act of 1932 and to broaden its scope.

Great Lakes–St. Lawrence Deep Sea Waterway Treaty

Hearings on the proposed Great Lakes–St. Lawrence Deep Sea Waterway Treaty were reopened in December for the purpose of hearing the testimony of Frank P. Walsh, Chairman of the Power Authority of the State of New York. Mr. Walsh stated that he considered it expedient to consider the program as the joint enterprise of the State of New York and the United States, with basic plans contemplating assumption of a full share of responsibility by each. Mr. Walsh was followed by James Grafton Rogers, Jr., Assistant Secretary of State, who testified that the State Department feels that the power to be developed can be most wisely turned over to whatever agency the State of New York provides for the purpose. He added his opinion that New York already had a sufficiently able technical organization and well founded policy under which the program could be handled.

Funds Sought for River and Harbor Work

The annual report of Lytle Brown, M. Am. Soc. C.E., Major General, U.S. Army, Chief of Engineers, for the past fiscal year, contains recommendations that Congress authorize appropriations totaling slightly over $39,000,000 as the amount that can be profitably expended in the fiscal year 1934 for the maintenance and improvement of existing river and harbor projects throughout the country. Of the total recommended, it is proposed to spend approximately $15,000,000 for improvement and $24,000,000 for maintenance.

R. F. C. Progress

During December, the Reconstruction Finance Corporation authorized loans for 12 self-liquidating projects totaling $6,855,000, bringing the grand total of loans authorized to $146,252,500. The loans authorized during December include two sewerage projects; five projects for the construction or extension of water supply systems, including a loan for the construction of El Capitan Dam for the City of San Diego; three projects for the construction of public markets; one project for levee construction for flood control; and one project for the construction of college dormitories.

Supreme Court Considers Chicago Diversion Controversy

On December 6 the Supreme Court heard arguments in the so-called Great Lakes Water Diversion Case, which was reopened for consideration on complaint of the States of Wisconsin, Minnesota, Ohio, and Michigan that the Sanitary District of Chicago is not complying with the terms of the court's decree requiring a gradual diminution of water from Lake Michigan, and construction of a sewerage disposal system by the district. The court was assured by counsel for the district that the terms of the decree entered April 21, 1930, requiring completion of the project by 1938, will be complied with.

The court has appointed a special master in the case with directions to report by April 1, 1933, as to "(1) The causes of the delay in obtaining approval of the construction of controlling works in the Chicago River and the steps which should now be taken for such approval and prompt construction; (2) The cause of the delay in providing for the construction of the Southwest Side Treatment work and the steps which should now be taken for such construction, or in case of a change in site, for the construction of an adequate substitute; (3) The financial measures on the part of the Sanitary District or the State of Illinois which are reasonable and necessary in order to carry out the decree of the court."

Uniform Mechanics Lien Act Made Available

Completing an eight-year study, the Standard State Mechanics Lien Act Committee of the Bureau of Standards has made a report to the Secretary of Commerce endorsing a Uniform Mechanics Lien Act recommended for enactment by legislatures of the several states. The department states that the proposed uniform state statute provides a more equitable basis for liens against real property by laborers, persons who furnish material, subcontractors, and others engaged in building construction and related work. The final draft of the act recently received the approval of the National Conference of Commissioners on Uniform State Laws and of the American Bar Association.

Annual Meeting of Assembly of American Engineering Council

The Assembly of American Engineering Council held its annual meeting in Washington, January 13–14, 1933. The meeting was attended by more than 50 representatives of the national, state, and local engineering societies which comprise American Engineering Council.

ELECTION OF OFFICERS

John F. Coleman of New Orleans, Past-President Am. Soc. C.E., member of the Engineers' Advisory Board of the Reconstruction Finance Corporation, and William H. Woodbury, of Duluth, a former president of the Minnesota Federation of Architectural and Engineering Societies, were elected vice-presidents for the two-year term, 1933–1934. Farley Osgood was reelected Treasurer for the term of one year, and A. J. Hammond, President, Am. Soc. C.E., was reelected chairman of the Finance Committee.

COMMITTEE RECOMMENDS COORDINATION OF WATER RESOURCES FUNCTIONS

The Council's Committee on Water Resources submitted a carefully prepared report covering an investigation of the water resources functions of the Federal Government. As a result of its studies, the committee made the following recommendations, which received the approval of the Assembly:

1. The immediate establishment of an interdepartmental Board of Water Resources Investigation for the purpose of correlating the investigational functions of the various Federal agencies dealing with water resources.
2. The inauguration of studies for the purpose of investigating the feasibility of establishing similar boards to correlate the supervisory and regulatory functions relating to water resources.
3. The delegation of all construction relating to water resources to a Bureau of Construction within a Department or Division of Public Works, when established.
4. Studies looking to the ultimate establishment of a Bureau of Water Resources within the proposed Division of Public Works wherein would be coordinated, as far as feasible, activities relating to water resources.

PROPOSED MODIFICATIONS OF RELIEF ACT

The Assembly was advised by the chairman of the Committee on Government Expenditures that that committee had received and considered a report of the Committee on Public Works of the American Society of Civil Engineers to its Board of Direction recommending modifications in Title II of the Emergency Relief and Construction Act of 1932. The recommended modifications received the approval of the Assembly.

ASSEMBLY DISCUSSES ECONOMIC REPORT

The contents of the second progress report of the Council's Committee on Economic Balance were briefly described by Ralph E. Flanders, Chairman, and considerable discussion by individual members of the Assembly was evoked. The Assembly adopted a recommendation that the report be received and be made available for publication and distribution.

After a discussion of Technocracy, a resolution was adopted to the effect that the engineering profession believes the statements and conclusions of the group calling themselves "technocrats" to be unwarranted and untenable. The resolution states in part: "The alleged unmanageability of a machine economy has not been proven. Its dislocations are traceable to improper and unskilled use rather than to inherently harmful characteristics. Complete replacement of men by the machine is precluded by the law of diminishing returns. Instances are increasingly in evidence. Contrary to the pronouncements of Technocracy, applied science holds the promise of better things to come in a society which fearlessly and intelligently meets its problems. It is the considered opinion of American Engineering Council that our present economic structure contains within itself the possibilities of progressive improvement and of the attainment of higher standards of living."

LEGISLATIVE ACTIVITIES

Various committees reported to the Assembly as to the features of pending or proposed legislation of interest to engineers. On two of the bills the Assembly acted as follows:

That Council oppose H. R. 13917, introduced by Culkin (declaring the policy of the United States with respect to irrigation and reclamation), as it believes it to be so drastic as to prohibit the development of a sound policy with respect to Government reclamation. In connection with this bill, the Assembly adopted the following policy: "The Government Reclamation Policy should be considered from now on with a great deal of care. No new areas should be brought under cultivation with public funds until every aspect of the increased production which will follow has been canvassed. It is quite possible that the Government should be pursuing a policy completely opposite to that of reclamation: namely, the surveying of farm lands to determine marginal areas which should be reforested, and the purchase of them for that purpose."

That Council oppose H. R. 11051 (to provide for the leasing and other utilization of the Muscle Shoals properties in the interest of national defense and of agriculture, and for other purposes). This action was based on a careful report made by a subcommittee of the Public Affairs Committee indicating that the proposed legislation is neither feasible, economical, nor sound from an engineering standpoint. The stand taken is in conformity with previous actions by the Assembly regarding Muscle Shoals.

RESOLUTIONS AND POLICIES ADOPTED

A recommendation that Council urge engineering groups in each state to actively participate with others in an endeavor to have the proposed Uniform Mechanics Lien Act adopted by the several state legislatures, was approved.

A resolution relating to the advancement of topographic mapping through cooperation with state officials was adopted, and the officers of Council were authorized to take steps looking toward the acceleration of such cooperation.

The Assembly was advised of the excellent progress being made by the Federal Employment Stabilization Board and of the possibilities for extending this work to the several states. The Assembly adopted a recommendation that Council cooperate in an effort to bring to the attention of state legislatures the advisability of setting up state and local employment stabilization boards to permit advanced planning of public works.

The Assembly expressed approval of the better housing movement and authorized the officers of Council to bring this movement to the attention of its state committees on Engineers and Employment for their consideration and participation as opportunity might present.

The Assembly authorized the appointment of a special committee to consider such problems relating to tax policies as might be called to the attention of Council. It also authorized the appointment of a special subcommittee to study legislation designed to extend the Federal Classification provisions to Government employees in the field service.

LEGISLATION PERTAINING TO REGULATION OF TRANSPORT AGENCIES

The Assembly considered a report by a subcommittee relative to legislation for regulation of interstate commerce and adopted the following resolution:

WHEREAS, Our national system of transportation comprises railroads, highways, pipe lines, waterways, and air ways, and

WHEREAS, The only present Federal regulation of such transportation is that of the Interstate Commerce Commission over the railroads, therefore

Be It Resolved, That American Engineering Council favors the general principle of extending equitable Government regulation to cover all forms of interstate transportation.

ADMINISTRATIVE BOARD APPOINTED

The representatives of Council's member organizations selected the personnel to form the Administrative Board for 1933. This board will be constituted as follows: President, William S. Lee, M. Am. Soc. C.E., Power Building, Charlotte, N.C.; Treasurer, Farley Osgood, 31 Nassau Street, New York, N.Y.; Executive Secretary, L. W. Wallace, 744 Jackson Place, Washington, D.C.; and Vice-Presidents: John F. Coleman, Past-President, Am. Soc. C.E., Hibernia Building, New Orleans, La.; R. C. Marshall, Jr., M. Am. Soc. C.E., National Press Building, Washington, D.C.; L. B. Stillwell, M. Am. Soc. C.E., 11 West 42nd Street, New York, N.Y.; and W. H. Woodbury, M. Am. Soc. C.E., Wolvin Building, Duluth, Minn.

Each member organization is entitled to representation. The representatives of the American Society of Civil Engineers are: Herbert S. Crocker, Past-President, Am. Soc. C.E.; A. J. Hammond, President, Am. Soc. C.E.; John P. Hogan, M. Am. Soc. C.E.; and George T. Seabury, Secretary, Am. Soc. C.E.

ITEMS OF INTEREST

Engineering Events in Brief

Civil Engineering for March

THE MARCH ISSUE OF CIVIL ENGINEERING is to be devoted exclusively to a résumé of the papers given at the Eightieth Annual Meeting of the Society, just passed, which convened in New York on January 18. The problems of present-day economics, which occupied the General Session, were presented in three papers dealing with long-range planning and the future of business, international relations, and the economic situation that the railroads now find themselves required to face.

Of interest to highway engineers is the paper containing the latest word on the cost of delays to traffic by reason of insufficient roadway capacity. Two others deal with the methods adopted in Washington, D.C., and in New York to control the tearing up of street pavements in order to lay, repair, and maintain the public utility structures beneath.

Of the papers presented before the Structural Division, one by L. E. Grinter, Assoc. M. Am. Soc. C.E., on a method of structural analysis by successive corrections, has already appeared in the January issue of PROCEEDINGS, and therefore will not be printed in CIVIL ENGINEERING.

At the Annual Meeting, progress reports of unusual value were presented by two Division committees, one on "Wind Bracing in Tall Buildings" and the other on "Structural Alloy and Heat Treated Steels." It is hoped that these reports will be available for printing in brief in the March issue.

Papers read before the Sanitary Engineering Division include two on the use of coagulating chemicals in purification plants. In one, the method used at the Montebello Filters, in Baltimore, Md., to manufacture the liquid alum required for the formation of floc is described. Baltimore was probably the first city to use a weak solution of alum for direct application to the water to be treated. The other paper describes the method of using ferric salts as coagulants and the difference between their action and that of alum. The use of compounds of iron has now become more common, because of their availability in sufficient quantity and at a reasonably low price, low enough to compete with alum. As regards the construction phases of sanitary works, one article deals with the use of deep tunnels for the delivery of water to large cities and another with the present status of the construction of the Wards Island Sewage Treatment Works being built on the East River, in sight of the famous Hell Gate Arch Bridge, New York.

Any engineer who has had to spread the cost of a city planning project over an assessment district knows of the criticism, protest, and caustic comment that come from the taxpayers regarding the amount of their individual assessments and the method used to define the district and spread the assessment. A paper based on the experience of St. Louis on a large street widening and improvement program provided an interesting afternoon at the Annual Meeting and is to be published in shortened form in the March issue of CIVIL ENGINEERING.

Another article is being prepared from a paper describing the construction of the great "Diagonal Bridge" across the New Jersey meadows between Newark and Jersey City, over which the New Jersey Express Highway passes. Two valuable articles on the design and construction of railroad grade separations, presented before the joint session of the Construction and Structural Divisions, deal with some of the problems encountered by the Delaware, Lackawanna, and Western Railroad in New Jersey.

So much general interest attaches to the determination of the clearances of bridges constructed over the navigable waters of the United States that the article defining just what a navigable waterway is, by no less an authority than the Assistant Chief of Engineers of the U.S. Army, will be of special significance.

The March issue will be completed by discussions, in the form of letters to the editor, of articles that have previously appeared, and by items covering the activities of the Society itself, together with the usual departments. Those who attended the Annual Meeting will need the next issue as a record and reminder of the technical phases of the sessions; those who were unable to attend will have in this issue an opportunity to review the latest engineering thought on the various subjects presented.

Five Strathcona Fellowships Available

FIVE FELLOWSHIPS in transportation are again being offered by the Yale University Graduate School. These fellowships, $1,200 each, are endowed by the will of the late Lord Strathcona and are known as the Strathcona Memorial Fellowships in Transportation. Their primary purpose is to promote advanced work, especially research, with special reference to construction, equipment, and operation of railroads and the other engineering problems connected with the efficient transportation of passengers and freight by land, water, and air. The broader aspects of the economic, financial, legal, and legislative phases of transportation are included in the lists of subjects that the Fellows may select for investigation and study. It will be possible for them to combine this work with that for an advanced degree. The holder of a Strathcona Fellowship must possess his first degree from an institution of high standing, and preference must be given in making the award either to those who have been connected in some capacity for at least two years with the railroads of the Northwest, or to their sons.

Applications for these fellowships should be addressed to the Dean of the Graduate School of Yale University, New Haven, Conn., before March 1, on blanks which may be obtained from him. Applicants must submit with their application a brief biography, a statement giving the reasons for desiring to pursue advanced work, the subject contemplated for special study, and a certified record of their previous courses of study in college or technical school, with their standing therein. They should also submit testimonials bearing on their qualifications. A recent photograph of the applicant is requested.

St. Louis Engineers Entertain Legislators

ABOUT EIGHT years ago a group of St. Louis engineers, in the belief that closer contact between them and the state's lawmakers would bring about a better understanding, gave a dinner in St. Louis to members of the Missouri Legislature. At that time 28 engineers were hosts and 21 legislators were guests. The feeling promoted by this first dinner was so cordial that similar dinners have been given biennially ever since.

At the Fifth Biennial Dinner, held on December 20, 1932, architects and representatives of other branches of the building industry, present at the St. Louis Building Congress, joined the engineers as hosts to the legislators, of which 27 were present. Among the hosts, who numbered 52, were a goodly number of members of the Society.

The purpose of these dinners, in addition to establishing friendly contacts, is to enlighten the guests on strictly non-political subjects of public welfare, in which the experience and training of the engineers may be of service. The speakers and subjects presented at the recent meeting were as follows: "Memorandum for Housing Legislation," by E. J. Russell; "Death and Taxes" (discussion of financing sewerage systems), by W. W. Horner, M. Am. Soc. C.E.; "Community Planning," by S. Herbert Hare; "Registration of Architects and Engineers," by Alexander S. Langsdorf; "Significance of the State Geological Survey," by Carl G. Stifel; "An Unfair Condition" (discussion of an ordinance of the City of St. Louis relating to excavations for building construction, for the changing of which an act of the State Legislature would be required), by William C. E. Becker, Assoc. M. Am. Soc. C.E.

Standard Form for a Fulfillment Bond

DEVELOPED AND ADOPTED BY THE TEXAS SECTION OF THE SOCIETY

In 1932 the Texas Section of the Society initiated an investigation of the various forms of construction bonds in use in Texas. The Section's committee was thoroughly convinced that the form of bonds in general use left much to be desired in the protection they afforded the owner, in their effect on the construction industry, and especially in their effect on the creditors of the contractor. A form of bond based on complete fulfillment of all the terms of the contract by the surety in case of default by the contractor was prepared with the assistance of competent legal advice, and after presentation, discussion, and revision was adopted by the Texas Section on October 22, 1932.

This article has been condensed from a more complete report of the Local Section's study and conclusions, which appeared in the December issue of "The Texas Engineer," the official publication of the Texas Section. It is here published for the information of members. The subject has not been considered by the Board of Direction and no action of any kind has been taken by the Society as a whole on the subject of surety bonds for contractors.

AN INVESTIGATION of construction bonds led the Committee on Contracts of the Texas Section to discover that there are two well defined and basic theories of surety underwriting, or bonding, on construction work. The first theory of surety underwriting is that the surety simply guarantees that the building, structure, or project will be completed, and indemnifies the owner from any loss above the contract price, but assumes no liability for the contractor's creditors, nor does it in any way guarantee the reliability and the responsibility of the contractor. This is the form of bond that is generally found in present-day use, and is known as a "performance bond." On public works the usual "statutory bond" assumes substantially the same form as the "performance bond," but the lien laws have been read into the "statutory bond" by the courts of various states, and thereby its coverage has been extended to those who enjoy the additional protection afforded by such lien laws.

The second theory of surety underwriting is that in the event the contractor defaults, the surety immediately assumes all the obligations imposed upon the contractor by the terms of his contract, re-awards the work to another contractor, or performs and completes the work itself, and guarantees the full payment of all just creditors, and that all obligations of every sort and kind required to be performed by the terms of the contract are fulfilled. In other words, such a bond should be a guarantee to the owner of the full accomplishment or complete fulfillment of all the obligations imposed on the contractor by the terms of his contract, and in reality should be prima-facie evidence of the reliability and responsibility of the contractor. As the term "fulfillment bond" carries the idea of making good on a promise, agreement, or contract, it is, perhaps, the better name to use in distinguishing this form of bond from a "performance bond," or a "completion bond."

An examination of the practical results from the use of the present-day "performance bond" disclosed that many surety companies have little compunction in resorting to every available technicality afforded by court decisions and the statutes to limit their liability. Contrary to the understanding of most owners when they accept a surety bond, that it guarantees the complete fulfillment of all the terms of the contract, it was found that the "performance bond" does not afford such protection.

When a contractor defaults, the usual procedure is for the owner to turn over to the surety the retained percentage and balance due on the contract price. The surety uses this fund to finish the work, and then often denies liability to many just creditors. In many cases the surety companies have adopted the policy of paying no claims except at the end of court procedure. This has proved to be a profitable business for some surety companies.

The committee also found that under the present "performance bond" the surety is required to pay only for the machinery, equipment, and materials that are actually incorporated in the work, and the labor used directly on it. This means that none of the creditors who furnish such items as tools, construction plant equipment, forms, power, rentals, transportation, communication, or professional services, are protected by the usual "performance bond." In other words, under modern construction, where such a large part of the work consists of plant, machinery, and equipment, the statutory bond in reality fails to protect a large number of just creditors on the usual engineering project. This also applies to Federal work, where, under the Heard Law, a contractor is required to furnish a bond to guarantee only payment for labor and materials.

Believing that the execution of a surety bond was prima-facie evidence of the reliability and the responsibility of the contractor, many owners and engineers have relied implicitly upon the ability of the contractor to furnish a surety bond as establishing responsibility. The average owner, who usually builds but once, and also many public officials, are greatly handicapped in passing upon the responsibility of a contractor. Furthermore, if the surety bond is so written as to establish responsibility, there would be no demand, or need, for the present attempt to establish prequalification of bidders.

The investigation showed that most owners, including public officials, are deeply interested in seeing that all creditors who have contributed in any manner to the construction of any project are paid in full. As a general rule, they are ready and willing to pay a fair price for good workmanship and materials and adequate protection. The owner always provides in his contract that the contractor must pay all just creditors, and will not permit a solvent contractor to escape such obligations. By the same adherence to fair dealing, it would seem to be consistent and reasonable for the owner to demand and obtain a form of bond that protects everyone identified with his construction program.

The effect of present bonding practice on the construction industry, including contractors, engineers, and architects, was clearly indicated in the case of the Agricultural and Mechanical College of Texas. The board of directors had had some very disappointing experiences with unskilled and irresponsible contractors in the past. Under the law it is compelled to accept the lowest bidder. In order to protect itself from accepting the lowest bid of any contractor who chose to submit a bid, the board of directors adopted the day-labor method of carrying out its extensive building program. The result was that not only did the contractors lose this business, but the surety companies had only a few bonds to make for some of the subcontractors.

The deciding factor in returning to the contract method was the possibility of adopting a form of bond that would actually ensure the work's being awarded to capable and competent contractors.

With all these facts before it, the Section's committee on contracts decided that a bond should be written specifying that in the event of failure of the contractor, the surety should immediately step into his place, have the work completed, see that all just creditors are paid in full, and that every obligation imposed on the contractor by the terms of his contract is completely fulfilled. The form was prepared and agreed upon by four attorneys who have had extensive experience in contract law and legislation, and are recognized as outstanding lawyers and counselors. The Committee on Contracts adopted it as meeting the purposes intended and submitted it to the Texas Section, at its spring meeting in May 1932, where it was unanimously approved and adopted.

As soon as this form was approved by the Texas Section, a number of engineers and owners incorporated it in the contracts for work they proposed to construct. Immediately protests from the surety companies developed. The committee made an additional investigation, and requested some of the ablest representatives of the surety companies to present their reactions to the provisions contained in the new form of bond. These observations were carefully studied, and it was agreed by the committee that two of the objections raised by the surety representatives were sound and should be corrected. The bond form was revised, presented again to the Texas Section at its fall meeting on October 21, 1932, thoroughly discussed, and adopted.

One observation of the surety representatives was that, as the "fulfillment bond" imposes on the surety more obligations than the "performance bond," its adoption would immediately be accompanied by an increase in premium rates. This is the best evidence that the present form of bond is deficient and does not accomplish the purposes generally intended. It is agreed that the premium rate on a "fulfillment bond" should not be the same as the rate on a "performance bond." By the same reasoning, surety companies should not enforce the same premium rates against all contractors, regardless of their experience, financial responsibility, and the risk involved. The rates on life insurance are determined by age, health, and other considerations.

It would not seem unreasonable to suggest a sliding scale of premium rates on bonds, based on experience rating, where each contractor would be rated according to his ability, experience, and financial responsibility relative to the particular risk under consideration. From our preliminary investigation of the premium rates it is believed that when surety underwriting is conducted on a sound and equitable basis, and surety credit is bestowed and extended only where it is deserved, there should be no occasion for any material increase in the present premium rates to responsible contractors.

The committee has been confronted several times by the surety representatives with the argument that contract bonds were originally conceived from a demand created by the owners to protect themselves against losses through failure of the contractor, and that it was not then the purpose to protect any creditors. There is no doubt but what this statement is true. But times and conditions have changed during the past twenty years. Owners were then free to select their contractors on the basis of skill, integrity, and responsibility. They provided insurance against calamities and unforeseen conditions through a contract bond. They were not confronted with ordinances, statutes, and court decisions requiring the work to be awarded to the lowest bidder and that a bond must be furnished by a surety company. Neither did they have to contend with the various lien laws. Nor were the surety companies so organized as to enforce uniform rates, and tentatively determine responsibility of contractors, and incidentally, control, at least to a large extent, the award of contracts. The ability to furnish a surety bond did not make a contractor, nor enable him to obtain a contract, and it took more than a contract and a pleasing disposition to obtain a bond. Furthermore, owners are more interested in the creditors than formerly and are demanding protection to take the place of the discretion they originally enjoyed.

The Board of Directors of the Agricultural and Mechanical College of Texas has adopted this form of bond on all its proposed work and has already awarded contracts on some ten projects on which this form of bond was used and executed. The City of Dallas, Tex., has also adopted the new bond, and a number of contracts have already been awarded on which it was executed. Furthermore, a number of engineers in this territory are incorporating this bond in the contract for all work as it develops.

As a matter of information and interest to all members who have to deal in any way with construction contracts, the form of fulfillment bond adopted for use in Texas is here given in full:

Fulfillment Bond

STATE OF TEXAS }
COUNTY OF...................... }

KNOW ALL MEN BY THESE PRESENTS:

That we........................of the City

of..........County of..........State of......

as PRINCIPAL, and........, authorized under the laws of the State of Texas to act as SURETY on bonds for PRINCIPALS, and hereinafter called the SURETY, are held and firmly bound

unto............(OWNER), and to all subcontractors, superintendents, mechanics, workmen, laborers, and furnishers of machinery, equipment, appliances, tools, materials of all kinds requisite to complete the work, power, fuel, light, water, insurance, supplies, including commissary, money used to meet direct obligations of said contract, and furnishers of all other accessories and services of every sort and class used to complete said improvements, as their interest may appear, all of whom shall have the right to sue upon this

bond, in the penal sum of..........($........), lawful currency of the United States of America, for the payment of which well and truly to be made we do hereby bind ourselves, our heirs, executors, administrators and successors, jointly and severally, firmly by these presents.

This obligation, however, is intended as a bond, the conditions whereof are as follows:

WHEREAS, the above bound PRINCIPAL as CONTRACTOR on the....day of........193.., entered into a written contract with the above named OWNER, to furnish at the CONTRACTOR'S own cost and expense all the superintendence, labor, machinery, equipment, appliances, tools, materials, power, fuel, light, water, insurance, supplies, including commissary, and all other accessories and services required to complete the construction of certain improvements, as more particularly designated and described in the CONTRACTOR'S Proposal, The Agreement, The General Conditions of the Agreement, and Plans and Specifications, all of which collectively evidence and constitute the entire contract between the OWNER and the CONTRACTOR; and,

WHEREAS, the SURETY agrees: That the OWNER may make such changes and alterations in the Plans and Specifications, and order the CONTRACTOR to do such EXTRA WORK, all as is provided for in the General Conditions of the Agreement; that the OWNER and CONTRACTOR may agree upon an extension of time for completing any part or all of the work, and exercise any other forbearance on the part of either; that payment of any and all partial payments, and the final and full payment by the OWNER to the CONTRACTOR, as the same accrue and mature under the terms of said contract, shall not release the SURETY, and the SURETY assumes full responsibility for the fidelity of the CONTRACTOR in applying such payments to the liquidation of all claims based on indebtedness incurred by the CONTRACTOR in executing said contract; that it will look wholly to the CONTRACTOR for notice or advice of any matter material to be known as between the CONTRACTOR and the SURETY, and that the OWNER shall have no obligation to give the SURETY any advice or information concerning any such matter save upon written request by the SURETY therefor, whereupon such advice must be given in writing; that no defense will be urged by the SURETY against any claim or cause of action founded upon this bond and the contract secured hereby for any default of the CONTRACTOR or alleged failure to observe strict performance of said contract, and that the only defense that will be urged against any claim shall be the full and complete performance of all the obligations imposed by said contract and this bond, or default by the OWNER; that should the OWNER or any creditor be required to appeal to court procedure to enforce any obligation secured by this bond, and establishes said obligation or claim, then said OWNER or creditor shall be entitled to recover an additional ten (10%) per cent upon the amount of the judgement for the cost of collection.

NOW, THEREFORE, when the above bound CONTRACTOR, or the SURETY, either or both, shall have well and truly observed and performed all and singular the covenants, conditions and agreements, in the manner and time by said contract and this bond agreed to be done, observed and performed, by said CONTRACTOR and the SURETY, in accordance with the true intent and meaning of said contract, and the stipulations herein contained; and furthermore, when all CREDITORS of every sort and class for every obligation, in good faith incurred, in order to complete said improvements, (among said creditors shall be specifically included all subcontractors, superintendents, mechanics, workmen, laborers, furnishers of machinery, equipment, appliances, tools, materials of all kinds requisite to complete the entire work, power, fuel, light, water, insurance, supplies, including commissary, money used to meet direct obligations of said contract, and creditors for all other accessories and services such as royalties, rentals, leases, freights, transportation, telephone, telegraph, medical, legal and engineering, but this enumeration of specific creditors shall not be construed to exclude any non-specified bona fide creditor), who have filed with the OWNER and/or the SURETY an itemized statement of their unpaid claims, properly supported by affidavit, within ninety (90) days after the date each obligation matures, shall have been well and truly paid all money which may have become due and owing to them by the CONTRACTOR and/or the SURETY in the performance of said contract; then this obligation shall become null and void: Otherwise, it shall remain in full force and effect.

Witness the agreement hereto and the signing hereof

on this............day of........, A.D. 193..

....

By..
Principal

....

By..
Surety

Adopted by the Texas Section of the American Society of Civil Engineers, October 22, 1932.

The Committee on Contracts has labored earnestly to furnish the membership and the engineering profession a document that will meet the present demands of the construction industry, and fully protect owners. It does not contain a single provision that has not already been assumed by the contractor under the terms of the contract secured thereby. The committee believes that it is just as much the duty of the engineers and architects to see that the owner is properly protected by a form of bond that will furnish and guarantee all the protection and services desired by the owner as it is to assure him that the plans, specifications, and other contract documents are sufficient and adequate.

The complete report, of which this statement is a synopsis, was prepared by the Committee on Contracts, Texas Section of the American Society of Civil Engineers.

John B. Hawley, *Chairman*
J. M. Howe W. W. McClendon
A. P. Rollins A. J McKenzie

The Page of Special Interest

At the front of this issue, the Page of Special Interest carries a reproduction of an original pencil drawing of a railroad bridge in Oregon. This bridge was built for the Oregon Trunk Railroad across the Crooked River near Bend, in central Oregon, in 1912. The original drawing has been made available through the courtesy of Ralph Modjeski, M. Am. Soc. C.E., who acted as Chief Engineer for the bridge on the Oregon Trunk Railroad during the period of 1905–1915.

At this bridge site the track is 350

ft above the bend of the stream and the walls of the canyon are almost perpendicular. Of the design, Dr. Modjeski said:

"It was decided best to build a two-hinged arch of 340-ft span. . .to avoid the first artificial introduction of stress, or at least to simplify it. The span was consequently built as a three-hinged arch for dead load only. When all dead load was on and the temperature was at 60 deg, the connecting top chord section at the center was dropped into place and the holes in the splice plates carefully marked. The member was then removed, the holes accurately drilled, and the member replaced in its final position and riveted. The stress in this member is therefore zero under dead load alone and at normal temperature of 60 deg. The trusses of course were calculated with this condition in view, namely, that they act as three-hinge frames for dead load but as two-hinge frames for live load and temperature."

It is unusual in a pencil drawing to find such faithfulness to detail, such veracity of line and shadow as is to be found in this drawing. The artist, Mrs Belle Silvera, was a pupil, in the late nineties, at the Art Institute of Chicago and later became one of its teachers in drawing. She worked entirely in pencil and used a vertical stroke almost exclusively. She was a thorough artist, but her inborn modesty and timidity prevented her work from becoming better known.

All her drawings of bridges were done from nature. This proved to be quite a hardship at times, especially when a bridge was located in wild country. At the Crooked River Bridge the artist's vantage point had to be cleared of both brush and rattlesnakes before she could begin her work.

About 1923, Mrs. Silvera came to New York intending to finish some of her bridge drawings but death overtook her before she reached her objective.

Traffic Survey Provides Work for Unemployed

IN 1932, Mercer County, New Jersey, in which Trenton is situated, issued bonds for $400,000 to be used on county work especially planned for the relief of unemployment. A program of permanent highway construction was established; manual labor was used wherever possible; and the work afforded considerable employment for engineers and "white-collar" men. The county engineer, Harry Harris, M. Am. Soc. C.E., set aside a certain sum of money to be used on a county traffic survey to be conducted exclusively by engineers and "white-collar" workers.

The survey was begun on August 1, 1932, and for three months 60 different persons were used on a part-time basis as observers in the field, making the traffic counts. Of this number, ten were engineers who were employed continuously. The office force consisted of five engineers and draftsmen, and they served for five months on the computations, plans, and analysis of survey data.

The survey was of a comprehensive character and embraced almost every phase of the county traffic problem. Flow maps were prepared and special studies made for the by-passing of traffic at points of heavy congestion caused by the large volume of shore resort traffic in the summer months.

Since this is the first survey of its kind made in Mercer County, a fund of valuable information was secured. From the data collected and studies made the county can prepare a comprehensive highway plan, which will render the best service to the community at the lowest cost. The expenditure for labor was $4,600, which is about half the sum that would have been required under normal employment conditions. The survey, made possible only by the use of relief funds, afforded employment to engineers and others sorely in need of help, and was of great benefit to them even though the wage rate was very low.

It is not unlikely that a similar traffic survey would be very useful in other cities and counties. Such a survey serves the double purpose of giving relief to unemployed engineers and of gathering information needed to properly plan the highway system of the community.

Lime Crystals Damage Sandstone Slabs

AN INSTRUCTIVE EXAMPLE of selective decay which sometimes occurs when dissimilar materials are placed in physical contact in building construction comes from India and is mentioned in the *Records of the Geological Survey of India* for 1931, in "Weathering of Vindhyan Building Stone," by J. A. Dunn. Slabs of sandstone, 9 in. thick and 14 ft wide forming part of a veranda of the Jumma Musjia, were strengthened by pouring over them an 18-in. layer of lime concrete. Large fragments of sandstone have since continued to flake off from the lower surfaces of the slabs.

An investigation as to the cause of this progressive failure revealed that during the rainy season the pores of the sandstone become filled with water carrying calcium carbonate in solution, leached out of the lime concrete above. During the ensuing dry weather the water evaporates, and the calcium carbonate solution becomes concentrated near the lower surface of the sandstone slab. The tremendous force exerted by the formation and growth of calcium carbonate crystals forces off thin layers of sandstone.

In a subsequent laboratory test, a 9-in. block of the same sandstone was immersed 1 in. deep in a dilute solution of copper sulfate. In three months the solution had risen to 5 in. above the bottom of the block and a minute vein of copper sulfate crystals formed, which later developed a crack parallel to the bedding planes of the sandstone. Crystals continued to grow in the crack and adjacent to it until finally the top 2 in. was completely severed from the remainder of the block. A similar action is seen in the weathering of stone due to alternate freezing and thawing and in the damage to porous concrete exposed to alternate wetting by sea water and drying.

From information furnished by the Department of Scientific and Industrial Research, Building Research Station, Watford, Herts, England.

Advanced Courses of Study for Unemployed Engineers

ENGINEERS not otherwise engaged are improving their time by taking advanced courses of study, some at their own alma mater and others elsewhere. Early in January courses open to unemployed engineers were started in New York under the auspices of the Engineering Foundation, sponsored by the engineering societies, by the Professional Engineers' Committee on Unemployment, and by engineering colleges and individuals in the New York–New Jersey metropolitan district. That the opportunity thus offered is appreciated is indicated by the large enrollment of nearly 500.

Some of these disengaged engineers are taking several of the courses offered. For the present the lectures are being given in the Engineering Societies Building in New York, amidst familiar surroundings. The courses of study offered are Power Plant Engineering, Business Finance, Buildings and Mechanical Equipment of Buildings, Industrial Applications of Electricity, Sales Engineering, and Industrial Management. It is not surprising that the course in Business Finance is the most in demand.

In this movement there is a definite suggestion for other sections of the country where teaching talent is available and where there are groups of unemployed engineers.

Standard Methods for the Examination of Water and Sewage

THE AMERICAN PUBLIC HEALTH ASSOCIATION announces a new edition of *Standard Methods for the Examination of Water and Sewage*, prepared in cooperation with the American Water Works Association. The previous edition of this book is dated 1925. In the new edition, the seventh, many important additions and changes occur. For example, the section dealing with the method for the treatment of total hardness has been extensively revised; the ortho-tolidine test for chlorine is presented more exactly; the part describing the determination of the biochemical oxygen demand has been rewritten; the use of brilliant green lactose peptone bile is allowed in conjunction with standard lactose broth for water-purification plant control; and 23 methods of analysis that are not yet recommended as standard procedure, but which may be of use, are presented in abstract, with references.

The new edition is urgently recommended by the American Public Health Association and the American Water Works Association for use in place of the obsolescent 1925 edition, and may be secured from the American Public Health Association, 450 Seventh Avenue, New York, N.Y., at the price of $2.00 per copy.

Engineering as a Career, a Culture

Through the efforts of the Engineering Research Committee of the Engineering Foundation, a comprehensive pamphlet on "Engineering: a Career, a Culture," has been prepared and is now ready for distribution. It is the result of many months of effort by that committee. The pamphlet—prepared by experts in the fields of civil, mining, mechanical, electrical, and chemical engineering—presents pertinent facts in these important fields and a rather complete, though for these times an optimistic and perhaps somewhat romantic, picture of the profession in its major branches.

In its pages much is told about what engineers do, what qualities of mind and character a boy should have to become a successful engineer, and what sort of training and education he should receive. It suggests a number of uses that an engineering education may have in addition to the obvious one of providing a means of earning a living. Practicing engineers themselves will find this pamphlet good reading. It may assist them in answering the oft-recurring question, "Should my boy be an engineer?"

The pamphlet may be obtained from The Engineering Foundation, 29 West 39th Street, New York, N.Y., at 15 cents per copy.

NEWS OF ENGINEERS

From Correspondence and Society Files

H. C. Titus has been promoted from the position of Inspector of Engineering Works, Division of Engineering, State of New York Department of Public Works, to that of Senior Engineering Aid in the same department.

James P. Exum, who was formerly Principal Assistant Engineer for Ash-Howard-Needles and Tammen, of Kansas City, Mo., has recently accepted a position in the Texas State Highway Department, with headquarters in Austin.

E. V. R. Payne, who was formerly Resident Engineer on Bridge Construction for Frank P. McKibben, at Rochester, N.Y., has now accepted a position as Sales Engineer with the Shelt Company of Elmira, N.Y.

James I. Rooney has resigned his position as Bridge Designer for the New York Central Railroad to become Assistant Engineer in the Department of Plant and Structures, New York, N.Y.

T. Keith Legaré has been transferred from the position of Traffic Engineer for the South Carolina State Highway Department and is now Chief Labor Inspector in the same department.

Frank A. Biberstein, Jr., has accepted a position as Instructor in Civil Engineering at the Catholic University of America, Washington, D.C. He was formerly employed in the Engineering Department of the Columbia School of Drafting and Engineering, also located in Washington.

R. R. Schweitzer has been made Vice-President and General Manager of the Layne-Atlantic Company and the Layne Southeastern Company of Norfolk, Va. Formerly he was Chief Engineer for the same organization.

Burton W. Marsh has resigned his position as Traffic Engineer for the City of Philadelphia to enter the employ of the American Automobile Association in a similar capacity. He is located at the headquarters of the association in Washington, D.C.

Edwin F. Levy, who was formerly employed as an engineer by Barrett and Hilp, of San Francisco, has now accepted a position as Junior Bridge Design Engineer in the Division of Highways, engaged on the San Francisco-Oakland Bay Bridge. He is located in the same city.

Robert V. Labarre and Frederick J. Converse announce the association of Labarre and Converse, Consulting and Testing Engineers of Los Angeles. They will specialize in foundation engineering practice.

G. Gale Dixon, who has for the past six years served as Deputy Chief Engineer for the Mahoning Valley Sanitary District, has now resumed his practice in consulting engineering in Youngstown, Ohio, specializing in hydraulic and sanitary work.

William D. Hurst has accepted a position as Assistant Engineer in the City Engineering Department of Winnipeg, Manitoba, Canada.

T. G. Croom has severed his connection with the Department of Sanitary Engineering of the State Board of Health of Indianapolis, Ind., to accept a position as Sanitary Engineer with the New Albany Board of Health, New Albany, Ind.

Leslie W. Stocker is now Senior Civil Engineer in the Public Utilities Commission of San Francisco. Before the city's engineering service was reorganized under the jurisdiction of this commission, he served as Assistant City Engineer.

Edward K. Bryant, formerly with John L. Weber, Inc., Trenton, N.J., and Albert C. Jones, have bought the private business of H. Brevoort Smith and Frederick L. Branin and will conduct a general engineering business in Burlington County, New Jersey, and vicinity, under the name of Bryant and Jones, with headquarters at Mount Holly, N.J.

Sutton Van Pelt, who was formerly Superintendent of Construction for the Central Public Service Company of Chicago, has accepted a position as Construction Superintendent and Engineer for the MacDonald Engineering Company of the same city.

C. D. Hanover, Jr., has accepted a position as Associate Engineer with Williams and Brown, New York, N.Y. He was formerly employed as draftsman and designer by Waddell and Hardesty of the same city.

F. C. Taylor, of Niles, Mich., has accepted the position of City Manager of Harbor Springs, Mich.

Harold A. Brainerd has been promoted from the position of Contracting Manager for the American Bridge Company to that of Assistant General Contracting Manager of the same company. His headquarters have been moved from Baltimore, Md., to Pittsburgh, Pa.

Scott A. Baker has recently accepted the position of Superintendent of Public Works of Lansing, Mich.

C. A. McCollough has entered the employ of the Arthur McMullen Company, New York, N.Y., in the capacity of Title Engineer.

Orville Kofoid has now accepted a connection with the State Highway Department of Oregon, with headquarters in Juntura, Ore.

Frank H. Alcott, who was formerly associated with the National Lumber Manufacturers' Association, New York, N.Y., has now become Secretary-Manager of the New York Lumber Trade Association, of the same city.

George Harmon Bayles has resigned his position as Manager of Ulen and Company, of New York, N.Y., to accept a position as Research Engineer for the Sylvania Industrial Corporation of Fredericksburg, Va.

Percy A. Shaw, after an absence of many years from Manchester, N.H., has returned to this city and accepted the position of Superintendent of Water Works. During his absence from Manchester, Mr. Shaw has engaged in varied hydraulic engineering work.

Frayne L. McAtee and Fred Woolley, formerly with the Idaho State Bureau of Highways, are now engaged in private engineering practice in Boise, Idaho, under the partnership name of Northwest Testing Laboratory—McAtee and Woolley, Consulting Engineers.

Seaborn Jones Cunningham, who formerly served as Masonry Inspector for the Kansas City Southern Railway, Kansas City, Mo., has now accepted a position as Assistant Engineer with the Public Service Commission of the State of Missouri. His headquarters are still in Kansas City.

G. E. J. Pistor has resigned his position as Contracting Manager of the Hay Foundry and Iron Works, New York, N.Y., to become Contracting Engineer for the McClintic-Marshall Corporation of the same city.

John M. Adams has been appointed County Engineer of Whatcom County, Washington, with headquarters at Bellingham.

F. A. MacSheffray has been made Treasurer of Roberts-MacSheffray, Inc., Boston, Mass. He was formerly connected with the Noyes-Buick Company of the same city.

Changes in Membership Grades

Additions, Transfers, Reinstatements, Deaths, and Resignations

From December 10, 1932, to January 9, 1933, Inclusive

ADDITIONS TO MEMBERSHIP

Alcaine, Jose Eugenio, Jr. (Assoc. M. '32), Calle Arce 136, San Salvador, Salvador.

Anson Edward Hiram (Assoc. M. '32), Asst. Engr., Gibbs & Hill, Pennsylvania Station, New York, N.Y.

Bahmeier, Herman Frederick (Assoc. M. '32), Shiprock, N. Mex.

Barbee, Joseph Franklin (Jun. '32), Insp. and Asst. Engr., State Highway Dept. (Res., 91 West Lakeview Ave.), Columbus, Ohio.

Barker, Carl Leon (Jun. '32), Box 1191, University, Ala.

Beck, Thomas George Gordon (Assoc. M. '32), Faculty Club, Univ. of California, Berkeley, Calif.

Benejam, Raúl Gayá (Jun. '32), Box 205, San Sebastian, Puerto Rico.

Billing, John Morton (Assoc. M. '32), Asst. Engr., Public Works Dept., Bentong, Pahang, Federated Malay States.

Boothe, Perry Mattison (Jun. '32), 1515 Crenshaw Boulevard, Los Angeles, Calif.

Bowman, Edward Knott (Jun. '32), 2317 Columbia St., Olympia, Wash.

Boylan, Frank Patrick (Jun. '32), 4052 North Franklin St., Philadelphia, Pa.

Buerkle, Herbert Cosmos (Jun. '32), Asst. Civ. Engr., Essex County Eng. Dept.; 37 Sunset Ave., Newark, N.J.

Buzzi, Edward Anthony (Jun. '32), 586 South Main St., Torrington, Conn.

Caramanian, Ara (Jun. '32), 3 White Terrace, Newark, N.J.

Carlsen, Christian Elmer (Jun. '32), 3033 Washington Boulevard, Indianapolis, Ind.

Chapell, Richard Vincent (Jun. '32), 51 North St., Milford, Conn.

Coffman, Irving Lee (Jun. '32), Insp., Phillips Petroleum Co., Kansas City, Kans. (Res., 2618 East 33d St., Kansas City, Mo.)

Cohen, Benjamin Carl (Jun. '32), 305 Lexington Ave., Apartment 6-D, New York, N.Y.

Cooper, Frank Scott, Jr. (Jun. '32), 1301 Roanoke St., S. W., Roanoke, Va.

Corfitzen, William Edward (Jun. '32), Cold Spring Harbor, N.Y.

Doolittle, Frank Baldwin (Assoc. M. '32), New York Representative, Leake & Nelson Co., 1845 Grand Central Terminal, New York, N.Y.

Dorfman, Julius (Jun. '32), 302 North American St., Philadelphia, Pa.

Dougherty, Donald Fix (Jun. '32), 41 East Howard St., Dallastown, Pa.

Downward, Paul Hollingsworth (Jun. '32), With Hart & Early Co., New York, N.Y. (Res., 78 Harrison St., East Orange, N.J.)

Drago, Emanuel Anthony (Jun. '32), 176 Grandview Ave., Mariners Harbor, N.Y.

Duym, William Anthony (Jun. '32), Clerk and Eng. Asst., New Jersey Bell Telephone Co., 540 Broad St., Newark (Res., 290 Richmond Ave., South Orange), N.J.

Eagle, Henry Carlson (Jun. '32), West Yellowstone, Mont.

Foster, Elmer Laurence (Jun. '32), 1814 Lockwood St., Indianapolis, Ind.

Frasch, Burrows Holcomb (Assoc. M. '32), Div. Engr., State Dept. of Highways (Res., 129 West Main St.), Newark, Ohio.

French, Frederick Carpenter (Assoc. M. '32), Office Engr., City of Chattanooga (Res., 540 South Crest Rd.), Chattanooga, Tenn.

Gelston, Arthur Sanford (Assoc. M. '32), Asst. Engr., Joint Highway Dist. 13; 2424 Dowling Pl., Berkeley, Calif.

Gibson, Esmond Allen (Assoc. M. '31), Care, Public Works Dept., Christchurch, New Zealand.

Goldblum, Joseph (Jun. '32), 1821 Roselyn St., Philadelphia, Pa.

Gruebmeyer, Orville William (Jun. '32), Chairman, State Highway Dept., R. R. 2 New Bremen, Ohio.

Hagmann, Wayne W. (Jun. '32), Ashton, S.D.

Hahn, Robert LeRoy (Jun. '32), 115 East Poplar Ave., Arkansas City, Kans.

Hallvik, Carl Clifford (Jun. '32), 918 Coeur d'Alene Ave., Coeur d'Alene, Idaho.

Hinchman, James Benjamin (Jun. '32), 316 Merriwether St., Cape Girardeau, Mo.

Hogan, Elmer Robert (Jun. '32), 4220 Aurora Ave., Seattle, Wash.

Johnson, Mason (Assoc. M. '32), Maintenance Project Engr., State Highway Dept. (Res., 1416 Craig Ave.), Corpus Christi, Tex.

Johnson, Roy William (Jun. '32), 7529 Tenth Ave., N. E. Seattle, Wash.

Jones, William Perry, Jr. (Jun. '32), 1304 West Stoughton St., Urbana, Ill.

Kahn, Emanuel Linde (Jun. '32), 3301 Douglas Boulevard, Chicago, Ill.

Kenny, Francis Joseph (Jun. '32), 136 Printz Ave., Norwood Station, Pa.

Kolesoff, Serge Ivan (Assoc. M. '32), Designer for City Engr. (Res., 1117 Seventeenth St.), Santa Monica, Calif.

Koperski, Joe John (Jun. '32), 2036 Thomas St., Chicago, Ill.

Koy, Justus John (Jun. '32), Clerk, Drafting Dept., United Gas System (Res., 1301 Waverly St.), Houston, Tex.

Kring, Charles Udell (Jun. '32), 506 West Main St., Clinton, Ill.

Larson, Carl Olof (Jun. '32), 627 South Denver St., Spokane, Wash.

McCaskey, Ambrose Everett, Jr. (Jun. '32), 156 Maple Ave., New Martinsville, W.Va.

McLernon, Ronald Hugh (Jun. '32), 851 Ackerman Ave., Syracuse, N.Y.

Mabbott, Lyle Willard (Jun. '32), 1133 South 12th St., Lincoln, Nebr.

Mark, Richard Shenk (Jun. '32), Eng. Asst., Bureau of Eng., State Dept. of Health, 28 East Third St., Williamsport, Pa.

Martoccio, Michael Joseph (Jun. '32), 2822 Decatur Ave., New York, N.Y.

Miele, Philip Victor (Jun. '32), 376 Clarendon Pl., Orange, N.J.

Moore, Hilton Huxley (Jun. '32), Pequannock, N.J.

Moore, Raymond LeRoy (Assoc. M. '32), Design Engr., Office of Res. Engr., Green and Clinton Counties, State Dept. of Highways, South Monroe St., Xenia, Ohio.

Mutterer, William Elmar (Jun. '32), 149 Hobart St., Ridgefield Park, N.J.

Nelson, Saul (Assoc. M. '32), Asst. Engr., N.Y.C.R.R. (Res., 532 West 215th St.), New York, N.Y.

Newman, James Roy (Assoc. M. '32), Senior Draftsman, U.S. Engr. Office, Box 443, Memphis, Tenn.

Noe, Charles Laurin (Jun. '32), 1860 Winfield Ave., Indianapolis, Ind.

Nyquist, Roy Alfred (Assoc. M. '32), Archt. Engr., A. Bentley & Sons Co. (Res., 201 Belmont Ave.), Toledo, Ohio.

Pajot, Clayton James Joseph (Jun. '32), Instr., Eng. Mechanics, Univ. of Detroit (Res., 13641 Dexter Boulevard), Detroit, Mich.

Paller, Ben (Jun. '32), 2159 West Roosevelt Rd., Chicago, Ill.

Patton, Maynard Adams (Jun. '32), 5614 Michigan Ave., Kansas City, Mo.

Pearson, Harold Miller (Jun. '32), 746 Eighth St., Richmond, Calif.

Powell, Fay Edwin (Assoc. M. '32), Engr. and Asst. Const. Quartermaster, Panama Canal, Box 275, Balboa Heights, Canal Zone.

Prancl, Charles (Jun. '32), 37-37 Twenty-Ninth St., Long Island City, N.Y.

Pritchard, Samuel Copeland (Jun. '32), 200 East Oakland Ave., Columbus, Ohio.

Rentenbach, Thomas Joseph (Jun. '32), 738 Hancock Ave., Hancock, Mich.

Runner, Harold Vernon (Jun. '32), 5526 Hunter Ave., Philadelphia, Pa.

Sabatelli, Emil Albert (Jun. '32), 1670 Eighty-Fifth St., Brooklyn, N.Y.

Salisbury, Lloyd Moss (Assoc. M. '32), With Constr. Dept., Equitable Life Assurance Society, 393 Seventh Ave., Room 1405, New York, N.Y.

Scelfo, Alfred John (Jun. '32), 169 Lafayette St., Newark, N.J.

Schad, Eugene John (Jun. '32), 10 North West St., Waukegan, Ill.

Schill, Warren Edward (Jun. '32), 51-16 Manila St., Elmhurst, N.Y.

Shute, Ellison Clement (Jun. '32), 125 West Olney Ave., Philadelphia, Pa.

Smith, Jack Kermit (Jun. '32), Higginsville, Mo.

Staniunas, John Francis (Jun. '32), 2151 Twelfth St., Troy, N.Y.

Stifler, Felix Royston (Assoc. M. '32), Foreman of Maintenance, U.S. Govt. (War Dept.); Bel Air, Md.

Strong, James Henry (Assoc. M. '32), Asst. Structural Engr., Fleet Air Base, Coco Solo, Canal Zone.

Sutliff, Harold Lester (Jun. '32), Palmer, N.Y.

Tate, John Wishart (Jun. '32), 66 Eighty-Sixth St., Brooklyn, N.Y.

Thompson, Glen Maxwell (Jun. '32), With Water Commr., Winnemucca (Res., 445 East 6th St., Reno), Nev.

Trevor, Harry Ramon (Assoc. M. '32), With Bureau of Public Roads; 1171 Bush St., San Francisco, Calif.

Troxler, Paul Dexter (Assoc. M. '32), Div. Engr., John Monks & Sons-Ulen & Co., Serres, Greece.

Vogel, Herbert Davis (Assoc. M. '32), Lieut., Corps of Engrs., U.S.A., Asst. to Pres., Mississippi River Comm., Box 665, Vicksburg, Miss.

Volino, Michael Anthony (Jun. '32), 325 East 31st St., New York, N.Y.

Vreeland, Robert Paul, Jr. (Jun. '32), 4 Ridgewood Terrace, Maplewood, N.J.

Westerberg, Torgny Joel (Jun. '32), 5809 Augusta Boulevard, Chicago, Ill.

White, Howard Leslie (Jun. '32), Asst. Locating Engr., State Highway Comm., 4th Floor, State House Annex, Indianapolis, Ind.

Willoughby, Robert A. (Jun. '32), 1925 West Lawn Ave., Madison, Wis.

MEMBERSHIP TRANSFERS

Cornell, Arthur Leland, Jr. (Jun. '27; Assoc. M. '32), Sales Engr., Am. Bitumuls Co. (Res., 1810 West Wisconsin Ave., Apartment 711), Milwaukee, Wis.

Cotton, Harry Edmond (Assoc. M. '19; M. '32), Sales Engr., New England Metal Culvert Co., 10 Alger St., Boston, Mass.

Franklin, William Robert (Jun. '26; Assoc. M. '32), 20 Claire Ave., Woodbridge, N.J.

Hall, Russell Alger (Assoc. M., '27; M., '32), Associate Prof., Civ. Eng., Union Coll., Schenectady, N.Y.

Ko, Choong Myung (Jun. '26; Assoc. M., '32), Box 284, Cleveland, Ohio.

Nichol, Frank Elliott (Jun. '27; Assoc. M. '32), Sales Engr., Truscon Steel Co., 1735 North East 56th Ave., Portland, Ore.

Plock, Henry John (Jun. '26; Assoc. M. '32), Instr., Drafting, Coll., City of New York, New York, (Res., 456 Macatee Pl., Mineola), N.Y.

Riddell, John Calvin (Jun. Oct. '24; Assoc. M. '32), 801 Highland Ave., Salina, Kans.

Wendell, Edward Willoughby (Assoc. M. '17; M. '32), Prin. Grade Separation Engr., State Dept. of Public Works, State Office Bldg., Albany (Res., Altamont), N.Y.

REINSTATEMENTS

Anderson, Lyttleton Cooke, M., reinstated Dec. 30, '32.

Andreen, Gustaf Birger, Assoc. M., reinstated Dec. 30, '32.

Brua, Elmer George, Assoc. M., reinstated Dec. 30, '32.

Gunn, John Patterson, Jun., reinstated Dec. 30, '32.

Harman, John James, M., reinstated Dec. 30, '32.

Kern, Francis Xavier, Assoc. M., reinstated Dec. 30, '32.

Lindhé, John Birger, Assoc. M., reinstated Dec. 30. '32.

Roberts, Harry Ashton, Assoc. M., reinstated Dec. 30, '32.

Rogers, George Edwin, Assoc. M., reinstated Dec. 30, '32.

Simpson, Charles Randolph, Assoc. M., reinstated Dec. 30, '32.

Walker, Edson Ozro, Assoc. M., reinstated Dec. 30, '32.

Weinert, Ferdinand Jacob Frederick, Assoc. M., reinstated Dec. 30, '32.

RESIGNATIONS

Bakewell, John, Jr., M., resigned Jan. 3, '32.

Barnes, James Newton, Jun., resigned Dec. 29, '32.

Belknap, Robert Ernest, Affiliate, resigned Dec. 21, '32.

Blakeslee, Elmer Frederick, Assoc. M., resigned Dec. 31, '32.

Campbell, David Stanley, Jun., resigned Dec. 31, '32.

Clyde, Harry Schley, Assoc. M., resigned Jan. 4, '33.

Conard, Frederick Underwood, Assoc. M., resigned Dec. 29, '32.

Donnelly, Albert Lee, Assoc. M., resigned Jan. 6, '33.

Findlay, Charles Owen, M., resigned Dec. 29, '32.

Fucik, John Frank, Jr., Assoc. M., resigned Jan. 3, '33.

Gellert, Nathan Henry, Assoc. M., resigned Dec. 29, '32.

Glenton, Federico, Assoc. M., resigned Jan. 3, '33.

Habermeyer, George Conrad, M., resigned Jan. 6, '33.

Hasbrouck, Ralph Josiah, Jun., resigned Dec. 16, '32.

Hedrick, Wyatt Cephas, Assoc. M., resigned Jan. 5, '33.

Hoff, John Edward, Jun., resigned Dec. 9, '32.

Howell, Franklin Jonathan, Jun., resigned Dec. 29, '32.

Jackson, John Brook, Assoc. M., resigned Dec. 29, '32.

Jacobs, Samuel Theodore, Jun., resigned Dec. 29, '32.

Jones, Albert Scarborough, Jun., resigned Jan. 4, '33.

Kales, William Robert, M., resigned Dec. 9, '32.

Kauer, Theodore Joseph, Jun., resigned Dec. 30, '32.

Long, Frederick Watts, Jr., Jun., resigned Jan. 3, '33.

Mackenzie, Kenneth Gerard, Affiliate, resigned Dec. 21, '32.

McCray, Howard Stowe, Jun., resigned Dec. 29, '32.

McNamara, Charles John, M., resigned Dec. 28, '32.

McNamara, Neil Stuart, Assoc. M., resigned Dec. 29, '32.

Manthai, Frederick Stephen, Jun., resigned Dec. 20, '32.

Mollard, Charles Elias, Assoc. M., resigned Dec. 31, '32.

Philpott, James Henry, Jun., resigned Dec. 29, '32.

Price, Keith Hargreaves, Jun., resigned Dec. 31, '32.

Reed, Thomas Bernard, Jun., resigned Dec. 29, '32.

Richardson, Robert Earl, Assoc. M., resigned Jan. 3, '33.

Robinson, Carl Walter, Jun., resigned Jan. 6, '33.

Smith, Henry Ambrose, Jun., resigned Jan. 6, '33.

Stealy, Kirk H., Jun., resigned Jan. 4, '33.

Thompson, John Means, Jr., Assoc. M., resigned Dec. 29, '32.

Tilton, Benjamin Ellsworth, M., resigned Dec. 29, '32.

Trueheart, Edward Garland, M., resigned Dec. 29, '32.

Tuttle, Lawrence Samuel, Jun., resigned Dec. 29, '32.

Ungrich, Martin Jacob, Assoc. M., resigned Jan. 6, '33.

Unkefer, Frederick Doyle, Assoc. M., resigned Jan. 6, '33.

Wight, Roland Henry, Jun., resigned Jan. 6, '33.

DEATHS

Colby, Branch Harris. Elected M., June 5, 1895; died Jan. 3, 1933.

Connett, Albert Neumann. Elected Jun., June 6, 1883; M., Oct. 1, 1890; died Jan. 1, 1933.

McConnell, Ira Welch. Elected Assoc. M., Dec. 7, 1904; M., Sept. 3, 1913; Director 1921–23; died Jan. 7, 1933.

Meyer, Lester Louis. Elected Jun., Oct. 1, 1926; Assoc. M., Jan. 25, 1932; died Dec. 27, 1932.

Skinner, Frank Woodward. Elected M., Sept. 1, 1886; died Dec. 24, 1932.

TOTAL MEMBERSHIP AS OF JANUARY 9, 1933

Members	5,818
Associate Members	6,323
Corporate Members	12,141
Honorary Members	19
Juniors	2,963
Affiliates	115
Fellows	5
Total	15,243

Men Available

These items are from information furnished by the Engineering Societies Employment Service, with offices in Chicago, New York, and San Francisco. The Service is available to all members of the contributing societies. A complete statement of the procedure, the location of offices, and the fee is to be found on page 97 of the 1932 Year Book of the Society. To expedite publication, notices should be sent direct to the Employment Service, 31 West 39th Street, New York, N.Y. Employers should address replies to the key number, care of the New York office, unless the word Chicago or San Francisco follows the key number, when the reply should be sent to the office designated.

CONSTRUCTION

Field Engineer; Assoc. M. Am. Soc. C.E.; 29; graduate; 3 years responsible position with public utility on conduit construction; $5^{1}/_{2}$ years experience on highways, bridges, buildings, and surveying. Good fieldman for contractor, architect, or utility company on any type of construction. Location anywhere. D-1586.

DESIGN

Structural Engineer; Assoc. M. Am. Soc. C.E.; 34; married; with 8 years experience in design and construction of pulp and paper mills. Best of references. Open for mill operation, office or construction engineer's positions, or any kind of professional work. Available now. Location anywhere. Speaks Russian. Naturalized. D-119.

Designer; Assoc. M. Am. Soc. C.E.; 37; married; member American Water Works Association; experienced in water works, sewage treatment plants, incinerators; 12 years experience. Associated with leading sanitary engineers; 6 years field; 6 years drafting and design; 5 years responsible charge of work. Active student with complete library and files. Can take charge of design if required. C-6422.

EXECUTIVE

Hydraulic Civil Engineer; M. Am. Soc. C.E.; 37; married; university graduate; 15 years experience in all phases of hydro-electric development; design, construction, and preliminary studies. Fully qualified by experience to plan, from cost standpoint, domestic and foreign locations, all types of dams and structures. Also estimates and reports, and large projects. Available immediately. C-9694.

Civil Engineer; Assoc. M. Am. Soc. C.E.; 30 years experience; chiefly specializing in food markets, cold storage, and refrigeration; has had considerable experience as general manager for sales division of electric refrigerators, domestic and commercial. D-1516.

Civil Engineer; Assoc. M. Am. Soc. C.E.; 42; married; $2^{1}/_{2}$ years university training in civil engineering; licensed; registered; adaptable to all conditions; executive ability; 20 years experience, field and office, half and half—drafting, computing, surveying, design, construction on mining, municipal, railroad, highway, subdivision, harbor development, and title engineering. Desires to resume responsible charge of work. D-1785.

Industrial Engineering Executive; M. Am. Soc. C.E.; 38; married; 19 years experience in design, construction, and supervision of new buildings and equipment and piping of manufacturing plants, including paper mills and their maintenance; textile; chemical and power plants; public buildings; specifications; municipal engineering; plumbing; heating and ventilation; refrigeration. Location immaterial. Available immediately. B-7752.

Graduate Engineer; M. Am. Soc. C.E.; University of Michigan, 1905. Very active and in excellent health. Extensive experience in the design and construction of sewerage and water supply systems, roads, and pavements. Desires position as highway engineer or city manager anywhere in the United States, or as sales engineer in Southern territory. D-1794.

Graduate Civil Engineer and Superintendent; M. Am. Soc. C.E.; 44; 23 years experience in drainage and flood control, highways and pavements, water supply and municipal improvements, and concrete and steel design and construction. Experience in Philippines and Central America. Knowledge of Spanish. Will accept responsible position anywhere. D-1808.

Available, Executive who understands and practices teamwork; M. Am. Soc. C.E. Long and varied experience, including responsible charge of surveys of land, irrigation projects, roads and railroads; construction of roads, dams, and canals for irrigation, docks, jetties, and buildings. Has tact, resourcefulness, and energy. B-3340.

Civil Engineer; Assoc. M. Am. Soc. C.E.; licensed professional engineer, New York State; 25 years experience in design and construction of steam and hydro-electric power plants, transmission lines of all capacities, including 220,000 volts, industrial plants, electric railways, valuations, estimates, specifications, and purchasing. Desires responsible charge of work. Location New York. B-5423.

Civil Engineer; Assoc. M. Am. Soc. C.E.; 37; married; licensed New York State; graduate of Massachusetts Institute of Technology; 6 years experience in surveys and construction of sewers and sewage-treatment plants (activated sludge and Imhoff types); also drafting, design, and estimating; $1^1/_2$ years experience in surveys and construction of New York City subways. Available immediately. B-3347.

Civil Engineer; M. Am. Soc. C.E.; married; graduate of Rensselaer Polytechnic Institute; licensed engineer, New York and New Jersey; 25 years experience on miscellaneous building construction, New York City, including work as office manager, inside and outside supervision, general estimating, closing contracts, purchasing materials, and building and equipment valuation; 5 years in municipal engineering on reports, design, construction, and assessments. D-1756.

Civil and Industrial Engineer; M. Am. Soc. C.E.; graduate; 15 years experience in design and construction of factories, chemical plants, power plants, structural steelwork for all classes of structures, and foundations. Has had full charge of drafting room, writing specifications, purchasing all kinds of construction materials, etc. B-2835.

Junior

Young Graduate Civil Engineer; Jun. Am. Soc. C.E.; graduate of Rensselaer Polytechnic Institute; 3 years varied experience in building construction; desires position; any kind of construction work. Location anywhere. C-7157.

Civil Engineer; Jun. Am. Soc. C.E.; 25; single; B.S. in C.E., University of Michigan; licensed civil engineer; 5 years with public utility as office engineer, chief of party, construction work; with U.S. War Department on hydrological and water-power development studies; 1 year with U.S. Bureau of Public Roads, on production and cost studies. Location anywhere. Available March 1. D-1787.

Civil Engineer; Jun. Am. Soc. C.E.; 25; single; M.S. in C.E., University of Illinois; 9 months experience as catenary draftsman on railroad electrification; 2 months as junior engineer with U.S. Geological Survey; 6 months as structural draftsman; $1^1/_2$ years as computer-checker with city surveyor; excellent references. Will work anywhere. Available immediately. C-6115.

Civil Engineer; Jun. Am. Soc. C.E.; 26; single; B.S. in C.E., Rutgers University, 1930; $1\ ^2/_3$ years as transitman for Essex County Highway Department; passed New Jersey State Civil Service Senior Draftsman examination. Desires working or teaching position in any branch of civil engineering, preferably one involving mathematics. D-663.

Junior Engineer; Jun. Am. Soc. C.E.; 23; graduate of Rutgers University, with degree of B.S. in C.E.; 16 months in private and municipal surveying and inspection; 7 months general engineering, topographical survey, layout, and construction of concrete dam, bridge, road, etc.; 22 months highway experience on construction surveys, design, estimates. Desires any engineering position, especially one in structural design. Prefers New York City or New Jersey. D-1799.

Civil Engineer; Jun. Am. Soc. C.E.; graduate 1930; neat; industrious; ambitious; resourceful. Speaks Italian, Spanish, English. Good mathematician; competent draftsman; 4 years experience. Capable of performing and supervising difficult drafting and computations for construction drawings, highways, sewers, pipe lines; $2^1/_2$ years highway experience. Desires work with reputable concern, consulting engineer, or as assistant in university. C-7279.

Georgia "Tech" Graduate; Jun. Am. Soc. C.E.; B.S. in C.E., 1929; 3 years experience with the railroad; surveying; designing; steel; concrete; soundings; inspections; bridges; tunnels; buildings, etc. Traveling experience in North and South America, Peru, Chile Colombia, Ecuador. Speaks Spanish fluently. Available now. Location immaterial. C-6128.

Junior Engineer; Jun. Am. Soc. C.E.; 23; single; graduate of Cooper Union; B.S. in C.E.; 2 years on city and farm surveys; $3^2/_3$ years, line and grade, field and office layout, estimating on subway construction. Desires engineering position. Location immaterial. D-1803.

Graduate Civil Engineer; Jun. Am. Soc. C.E.; 26; married; B.S. in C.E., with structural major; $2^1/_2$ years on railroad construction and maintenance; 6 months on highway design in U.S.B.P.R. Desires position in structural work—office or construction—with construction company, consultant, contractor, or architect. Location immaterial. Available immediately. D-1805.

Sales

Structural Engineer, Designer, and Salesman; M. Am. Soc. C.E.; 39; married; graduate C.E.; licensed; 18 years experience in structural designing, managing steel fabricating plant, and selling. Last 8 years head of consulting engineering office, specializing in structural designing for architects, owners, and contractors. Large acquaintance among architects and contractors in northern New Jersey. A-5489.

Graduate Civil Engineer; Assoc. M. Am. Soc. C.E.; 8 years varied structural experience; drafting, design, and construction; inspection, surveys, layouts, checking, estimating, and related work. Capacity to assume responsibility. Readily adaptable to new conditions. Desires suitable connection of any kind, including sales-engineering or instructorship. C-2605.

Engineer; Assoc. M. Am. Soc. C.E.; 38; married; degree; seeks connection as sales engineer, sales manager; investigation, reports, research work, including asphalt planking, industrial flooring, built-up roofing, membrane waterproofing, asphalt, asphalt emulsions, bridge-wearing surfaces, expansion joints, concrete admixtures, building materials, architectural promotion, highways, public health engineering, and municipal research. Experience in the United States and Canada. B-5254.

Structural Engineer Executive; M. Am. Soc. C.E.; 45; married. Extensive experience in management of steel fabricating business in western Pennsylvania and Ohio, directing sales and estimating, engineering and shop; also 3 years in general contracting business. Exceptional sales record. Available immediately. C-5095.

Teaching

Structural Engineer; Assoc. M. Am. Soc. C.E.; 30; married; degree of doctor of engineering; 5 years experience in structural design and research work in structural engineering and materials. Desires teaching position, research work in structural engineering and materials, or structural design. D-1792.

Assistant Professor of Civil Engineering; Assoc. M. Am. Soc. C.E.; 34; married; B.S. in C.E.; C.E.; will be awarded M.C.E. at Cornell University in June; $7^1/_2$ years successful teaching of mathematics and civil engineering; 3 years head of department in small college. Varied experience in drafting and construction. Prefers work abroad, teaching or general engineering. Will accept good offer in United States B-6677.

RECENT BOOKS

New books of interest to Civil Engineers, recently donated by the publishers to the Engineering Societies Library, will be found listed here. A comprehensive statement regarding the service which the Library makes available to members is to be found on page 87 of the Year Book for 1932. The statements made regarding the books are taken from the books themselves and this Society is not responsible for them.

Ancient Bridges of Mid and Eastern England. By E. Jervoise. London, Architectural Press, 1932. 164 pp., illus., 8 × 5 in., cloth, 5s 6d.

The history of these bridges is given, with some notes upon their construction and photographs illustrating 80 of the most interesting. The volume is the third of a series designed to record the existing old bridges in England.

Continuous Frames of Reinforced Concrete. By H. Cross and N. D. Morgan. New York, John Wiley and Sons, 1932. 343 pp., illus., diagrs., charts, tables, 9 × 6 in., cloth, $4.50.

This discussion of the analysis of statically indeterminate structures adheres closely to a small group of geometrical methods which have been evolved to meet the needs of students and have been found of value by engineers in practical design. Although the title refers to reinforced concrete, the methods are applicable also to steel structures.

Forschungsinstitut für Wasserbau und Wasserkraft e.V., München. Mitteilungen. Heft 1, 1928. Münich & Berlin, R. Oldenbourg, 39 pp., illus., diagrs., charts, tables, 11 × 8 in., paper, 4 rm. Contents: Untersuchung der Ueberfallkoeffizienten und der Kolkbildungen am Absturzbauwerk I im Semptflutkanal der "Mittleren Isar."

The investigations of discharge coefficients and pool formation were made upon models and upon the actual works themselves. The measurement of water by overflow weirs was also investigated and certain possible sources of error discovered.

Housing Objectives and Programs. Ed. by J. M. Gries and J. Ford. Washington, D.C., President's Conference on Home Building and Home Ownership, 1932. 345 pp., illus., 9 × 6 in., cloth, $1.15.

This final volume of the publications of this conference contains the reports of the six Correlating Committees, appointed to review the conditions revealed by the fact-finding committees and to present conclusions. Reports are published upon the following subjects: Technological Developments in Housing, Legislation and Administration, Standards and Objectives, Education and Service, Organization Programs, and Research.

Sanitation of Water Supplies. By M. P. Horwood. Springfield, Ill., and Baltimore, Md., Charles C. Thomas, 1932. 181 pp., illus., diagrs., charts, tables, 9 × 6 in., cloth, $3.

This book presents enough of the engineering, laboratory, and public health phases of the problem of water supply to afford a reasonably complete picture of the entire subject. The practices necessary to maintain or render a water supply safe and potable are emphasized, and the book admirably relates the subject to other sanitary and public health practices.

Zerstörungen an Steinbauten. By A. Kieslinger. Leipzig and Vienna, Franz Deuticke, 1932. 346 pp., illus., diagrs., charts, tables, maps, 10 × 7 in., paper, 25 rm.; bound, 27 rm.

Changes in temperature, improper construction, dampness, wind, smoke, plants, and animals often injure the beauty and safety of stone and brick buildings and monuments. The ways in which these agencies act are carefully reviewed in this account, based upon extensive studies of old and modern European structures. Much material of interest to engineers and architects is included.

CURRENT PERIODICAL LITERATURE

Abstracts of Articles on Civil Engineering Subjects from Magazines in This Country and in Foreign Lands

Selected items from the current Civil Engineering Group of the Engineering Index Service, 29 West 39th Street, New York, N.Y. Every article indexed is on file in The Engineering Societies Library, one of the leading technical libraries of the world. Some 2,000 technical publications from 40 countries in 20 languages are received by the Library and are read, abstracted, and indexed by trained engineers. With the information given in the items which follow, you may obtain the article from your own files, from your local library, or direct from the publisher. Photoprints will be supplied by this library at the cost of reproduction, 25 cents per page, plus postage, or technical translations of the complete text may be obtained at cost.

BRIDGES

Australia. Grey Street Bridge, Brisbane, A. E. H. Frew. *Commonwealth Engr.*, vol. 20, no. 3, Oct. 1, 1932, pp. 63–71. Design and construction of a highway bridge with a total length of 1,279 ft, including 3 arch spans 238 ft each; roadway is 40 ft wide.

British Columbia. Two Million Dollar Bridge in City of Vancouver, F. H. Fullerton. *Contract Rec.*, vol. 46, no. 50, Dec. 14, 1932, pp. 1371–1376. Construction of the Burrard Street Bridge, comprising concrete viaducts, four deck-truss spans, and one 315-ft through-truss channel span, aggregating 2,816 ft in length between abutments; steel fabrication and erection; construction of piers.

Concrete Arch, Construction. Concrete Arch Construction from Contractor's Viewpoint, E. C. Blosser. *Eng. and Contracting*, vol. 71, no. 11, Nov. 1932, pp. 257–259. Construction of a high-level bridge at Brecksville, Ohio, consisting of 5 arches having a span of 181¼ ft; each span has two 7-ft arch ribs spaced 28 ft center to center; rising from these ribs are narrow columns spaced at intervals of 19¼ ft, which carry deck and sidewalks; excavation; method of concreting; lighting system; cost $426,294.

Construction, Forms. Use Structural Plywood Forms on Illinois River Bridge. *Concrete*, vol. 40, no. 8, Aug. 1932, pp. 8 and 9. In constructing the east approach of the Cedar Street Bridge across the Illinois River at Peoria, Ill., excellent results were obtained through the use of plywood for form work; its use reduces labor costs on form work and on concrete finish.

Corrosion. Combating Corrosion with Oil. *Ry. Eng. and Maintenance*, vol. 28, no. 12, Dec. 1932, pp. 717–719. Delaware, Lackawanna, and Western Railroad sprays all floor members in open-deck steel structures to overcome corrosion caused by brine drippings; equipment used.

Germany. Neubau der Oderdeichbruecke bei Fuerstenberg, Alb. Massenberg. *Stahlbau (Supp. to Bautechnik)*, vol. 5, no. 15, July 22, 1932, pp. 113 and 114. Construction of new steel-truss bridge at Oder levee, near Fuerstenberg, Germany, having a main span 58.5 m long.

India. Bara Bridge Reconstruction, M. C. A. Henniker. *Royal Engrs. Journal*, vol. 46, Dec. 1932, pp. 678–685, 2 supp. plates. Construction of highway bridge, 181 ft long, with a main concrete arch span 114 ft long; use of temporary so-called Inglis pipe-truss bridge to support centering and aid in the construction of a permanent concrete arch.

Military. Replacement of Vauxhall Bridge, Monmouth, A. J. Macdonald. *Royal Engrs. Journal*, vol. 46, Dec. 1932, pp. 661–670, 4 supp. plates. Construction of so-called Inglis pipe-truss bridge 78 ft long.

Plate Girder, Welding. Electric Welding at Selby Swing Bridge. *Engineering*, vol. 134, no. 3488, Nov. 18, 1932, pp. 583 and 584, 2 supp. plates. Repair of hydraulically operated unequal-armed plate-girder iron bridge; repairs included the replacement of one small approach span by new welded structure and repairs to main swing span; new welded bridge span consists of four troughs built up of steel angles in the form of the letter "U."

Railroad Crossings, Design. Girderless Concrete Slabs Solve Headroom Problem, M. Hirschthal. *Eng. News-Rec.*, vol. 109, no. 23, Dec. 8, 1932, pp. 678–681. Lackawanna Railroad solves troublesome headroom problem and cuts yard fill 100,000 cu yd by using column and flat-slab construction, for overstreet crossings at Elmira, N. Y.

Steel Arch, Japan. Report on Construction Work of Jiuso-Bashi across Shinyodo-Gawa, S. Miwa. *Civ. Eng. Soc., Japan—Journal*, vol. 18, no. 9, Sept. 1932, pp. 1007–1017, 15 supp. plates. Design and construction of combined steel-arch and steel-girder bridge having a total length of 737 m, including 5 steel arches having a span of 64 m each; width of bridge is 20 m. (In Japanese.)

Wooden. Timber Bridges for Logging Railroads, W. J. Ryan. *West. Construction News and Highways Bldr.*, vol. 7, no. 22, Nov. 25, 1932, pp. 661 and 662. Structural features of Weyerhaeuser Timber Company bridges on logging railroad at Longview, Wash.; model of Howe truss used as guide in framing and assembling bridge.

BUILDINGS

Caissons, Concrete, Construction. Concrete Lagging Lines Open Caisson for Skyscraper Foundation. *Concrete*, vol. 40, no. 8, Aug. 1932, pp. 13 and 14. New concrete specialty employed in second unit of Field Office Building in Chicago; reduces quantities of excavation and concrete; in place of customary wood lining, innovation tested in one caisson of building consisted of specially designed reinforced-concrete lagging; cross section of individual unit resembles letter "T."

Concrete Construction. Stahlskelett und Eisenbeton als kombinierte Bauweise, H. Wolf. *Beton und Eisen*, vol. 31, no. 17, Sept. 5, 1932, pp. 263–266. Use of combined concrete-and-steel-frame construction in the erection of buildings; design of combined concrete-steel columns.

Wind Stresses. New Method of Wind-Stress Calculation in High Building Frames, F. Takabeya. *Hokkaido Imperial Univ.—Faculty Eng.—Memoirs*, vol. 3, no. 2, Oct. 1932, pp. 33–63. Rapid and exact method of analyzing skyscraper frame subjected to wind pressure; new equations, obtained from some hundred problems for series of similar frames, give bending moment at any point, either in arbitrary joint or in any section of column and girder; general characteristics of moment linear equations. (In English.)

CITY AND REGIONAL PLANNING

Development. Future Development of Large Towns, J. R. Oxenham. *Surveyor*, vol. 82, no. 3131, Nov. 25, 1932, pp. 477 and 478 (discussion) 478 and 479. Growth by expansion; satellite towns; establishment of new towns under their own authorities; replanning existing centers; size in relation to population. Before Inst. Mun. and County Engrs.

Laws and Legislation. Notes on Town Planning in England and Australia, J. N. Yeates. *Australian Surveyor*, vol. 4, no. 2, June 1932, pp. 98–104. Review of British and Australian legislative practice as to city and regional planning; metropolitan areas; powers and duties of central authority; powers and duties of local authorities. Before Inst. Surveyors.

Streets. Lay-Out of Roads in Towns, C. H. Bressey. *Structural Engr.*, vol. 10, (New Series) no. 12, Dec. 1932, pp. 490–495. Older town maps and their features; by-passes and widenings; bridges and approaches; wide streets and their origins; formative influences; dock approaches; civic centers; road dimensions; cross sections and types of roads; intersections; roundabouts; signals; subways; tunnels, etc.

Switzerland. Einige Bemerkungen zum Wettbewerb um einen Generalbebau-ungsplan fuer Lausanne, H. Bernoulli. *Schweiz Bauzeitung*, vol. 100, no. 16 and 17, Oct. 15, 1932, pp. 209–211 and Oct. 22, pp. 220–223. Comments on competitive designs of a new city plan for Lausanne, Switzerland.

CONCRETE

Admixtures. Effect of Clay as Admixture in Concrete, H. H. Scofield and A. N. Vanderlip. *Cornell Civ. Engr.*, vol. 41, no. 3, Dec. 1932, pp. 38–44 and 51. Report on tests made in the Materials Laboratory of the School of Civil Engineering, Cornell University, in cooperation with and according to, specifications by Col. Hugh Cooper and Company Inc., New York City, to study the effect of replacing 10 per cent of cement by weight with clay on concretes containing 5 and 6 bags of cement per cubic yard; summary of strength and permeability tests.

Aggregates, Gravel. Production of Aggregates from River Gravels in Plains Region—IV, J. H. Ruckman. *Rock Products*, vol. 35, no. 24, Dec. 10, 1932, pp. 17–20. Development of different types of plants from early sand dips to present plants.

Construction, Spain. Le beton dans la construction et l'industrie du ciment en Espagne, A. L. Franco. *Int. Assn. Testing Materials—Congress de Zurich Sept. 6–12, 1931*, vol. 1, 1932, pp. 1016–1021. Use of concrete for construction and cement industry in Spain; studies on constitution of cements and researches carried out in laboratories, notably those in microscopic analysis, have contributed considerably to this progress.

Dams, Earth, Concrete Construction. Concreting Plant for Madden Dam, A. J. Ackerman. *Eng. News-Rec.*, vol. 109, no. 23, Dec. 8, 1932, pp. 671–675. Plant for preparing aggregates and mixing and placing concrete to be used in the construction of the core of earth dam for water supply of Panama Canal designed for complete salvage and independent re-use of separate units; aerial tramway 1-mile long, capable of delivering 225 tons of gravel per hour to screening plant; gravel storage; transporting concrete.

Germany. Die Bleilochtalsperre im Thueringer Wald, R. Leonhardt. *Zement*, vol. 21, no. 46 and 47, Nov. 17, 1932, pp. 647–650 and Nov. 24, pp. 665–667. Bleiloch Dam in Thuringian Forest; particulars of concrete gravity dam on Saale River, 65 m high. Similar description previously indexed from various sources.

Grouting. Anregungen ueber die Verwendung von aufsteigendem Zementguss bei Betonbauten, G. Schneiders and A. Schneiders. *Bauingenieur*, vol. 13, no. 39/40, Sept. 23, 1932, pp. 497–501. Merits of method of lining shafts, tunnels, etc., under conditions of large water inflow; aggregates are deposited first and subsequently grouted with a jet of neat cement, working from bottom upward.

Hoover Dam Project, Concrete Construction. Construction of Hoover Dam, A. S. Park. *Compressed Air Mag.*, vol. 37, no. 10, Oct. 1932, pp. 3937–3942. Methods of obtaining and preparing aggregates for 4,400,000 cu yd of concrete to be poured.

Light Weight. Beurteilung der Wirtschaft lichkeit beim Leichtbeton, K. L. Mueller. *Zement*, vol. 21, no. 46, Nov. 17, 1932, pp. 650–653. Estimation of economy in light concrete construction; cost estimation; calculation of light concrete made in forms.

Mixing. Coordination of Basic Principles of Concrete Mixtures—VIII, J. A. Kitts. *Concrete*, vol. 40, no. 12, Dec. 1932, pp. 17–19. Needed laws of mixtures and known fundamentals; relation between fineness of cement and strength of concrete and mortar.

Roads and Streets, Concrete. How Highway Departments Utilize High-Early-Strength Cement. *Concrete*, vol. 40, no. 8, Aug. 1932, pp. 5–7. Many states use high-early strength cement; of value in avoiding long detours in mountain roads; increasing use in metropolitan area; use of ordinary portland cement; question of cost; effect of low temperature.

CONSTRUCTION INDUSTRY

Costs. Unit Bid Summary. *West. Construction News and Highways Bldr.*, vol. 7, no. 22, Nov. 25, 1932, pp. 668, 670, 672, and 674. Unit costs bid on river and harbor work, bridges and culverts, and street and road work in California, Utah, and Arizona.

Roads and Streets, Construction. Accident Prevention in Highway Construction, T. W. Walton. *Roads and Streets*, vol. 75, no. 12, Dec. 1932, pp. 501–503. Essentials of safe highway construction procedure. Before 21st Annual Safety Congress and Exposition.

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DAMS

Ambursen, Oregon. Construction of Thief Valley Dam, C. A. Betts. *Reclamation Era*, vol. 23, no. 12, Dec. 1932, pp. 194–196. Description of concrete buttress Ambursen-type dam, 268 ft long; maximum height 70 ft; summary of concrete control tests.

Buttress. Round-Head Buttress Dam, F. A. Noetzli. *Am. Concrete Inst.—Journal*, vol. 4, no. 4, Dec. 1932, pp. 161–183. Design features of a buttress type of dam in which water pressure is supported by buttresses whose upstream portion is enlarged laterally into bulb-shaped heads joined with buttress heads of adjacent units, thus providing continuous upstream face; typical designs for buttress units of 35, 50, and 60-ft spans, suitable for dams from 75 to 350 ft high; a description of the Don Martin Dam in Mexico.

Concrete Arch, British Columbia. Construction of Variable Radius Arch Dam, A. G. Graham and H. B. Muckleston. *Eng. Journal*, vol. 15, no. 12, Dec. 1932, pp. 537–547. Construction of variable radius concrete arch dam on Nanaimo River, British Columbia, 84 ft high and 166 ft long, for water supply of Nanaimo, B.C.; geological and construction conditions; application of pressure grouting to correct secondary stresses; costs; calculations as to strength of dam.

Construction Railroad. Construction of Hoover Dam, N. S. Gallison. *Compressed Air Mag.*, vol. 37, no. 9, Sept. 1932, pp. 3908–3912. Construction-railroad system, its equipment and operation.

Covered. Quetta Water-Supply, J. W. J. Raikes. *Roy. Engrs. Journal*, vol. 46, Dec. 1932, pp. 599–614, 5 supp. plates. Method of construction of lined water-supply reservoir, of 5,500,000 gal capacity, covered with vaulted galvanized iron roof, at Quetta, Afghanistan; native labor was used.

Hoover Dam Project. Ten Articles on Hoover Dam Planning, and Construction. *Eng. News-Rec.*, vol. 109, no. 24, Dec. 15, 1932, pp. 701–728. (2 cards—card 1.) Symposium consisting of ten papers: From Colorado River Compact to Closure of Black Canyon; Bidding and Planning for Construction Battle; Huge Blast Turns River Into Diversion Tunnels; Permanent Cofferdams to Be Large Earth-Rock Fills; Colorado River Board Approves Design of Dam; Review of Preliminary Construction Operations; and Placing 300,000 Yd of Concrete Tunnel Lining.

Reservoirs, Construction. Some Examples of Raising of Reservoir Embankments, J. C. O. Burns. *Surveyor*, vol. 82, no. 2133, Dec. 9, 1932, pp. 525–528. Four examples illustrating methods of raising earth embankment of water-supply reservoir. Before Inst. Water Engrs.

Steel. Why Not Steel Dams? C. M. Stanley. *Eng. News-Rec.*, vol. 109, no. 22, Dec. 1, 1932, pp. 652–654. Review of pros and cons of metal dam construction in the light of present-day developments in design, fabrication, non-corrosive metallurgy, and surface protection. Bibliography.

FLOOD CONTROL

California. Cucamonga Creek Water Conservation Project, T. C. Combs. *West. Construction News and Highways Bldr.*, vol. 7, no. 23, Dec. 10, 1932, pp. 691–693. Flood-control construction in basin of creek, in San Bernardino County, California, draining mountain watershed of 10 sq miles, and having an estimated peak flow of 4,000 cu ft per sec; conveyance of diverted flow; desilting and disposal of fine material; percolation; direct spreading; protection from surplus run-off; main and lateral roads.

Levee Construction. Belt Conveyor System Builds Levee Enlargement, *Contractors and Engrs. Monthly*, vol. 25, no. 6, Dec. 1932, pp. 15–19. Description of method used at Farrell, Miss.; equipment consisted of a spreader conveyor mounted on crawlers and capable of turning like a dragline; stream of dirt was delivered to hopper of this from conveyor on top of levee; to this top system a series of conveyors of varying lengths carried the dirt from two feeder conveyors.

Reclamation of Land, Rice Grass. Economic Possibilities of Rice Grass, J. Bryce. *Roy. Soc. Arts—Journal*, vol. 81, no. 4176, Dec. 2, 1932, pp. 62–75 and (discussion) 75–78. Problems experienced on tidal lands where terrain consists of mud or clay or mixture of these with sand and gravel; use of rice grass as a means of reclaiming land from sea; prevention of coast erosion; use of rice grass for fodder for stock; other possible uses.

FOUNDATIONS

Testing. Neuere Bodenpruefmaschinen, E. Franke. *Bauingenieur*, vol. 13, no. 35/36, Aug. 26, 1932, pp. 453–455. Description of several recently developed German testing machines by which both vertical and lateral resistance of the ground is tested; features of machine for testing vibrations in foundations.

HYDRAULIC ENGINEERING

Progress Report. Progress in Hydraulics. *Am. Soc. Mech. Engrs.—Advance Paper*, mtg. Dec. 5–9, 1932, 3 pp. Progress made in hydro-electric plants and hydraulic laboratories and in research.

HYDRO-ELECTRIC POWER PLANTS

Italy. Einige Erfahrungen bei der Nutzbarmachung der Italienischen Wasserkraefte, F. Toelke. *Bauingenieur*, vol. 13, no. 37/38 and 39/40, Sept. 9, 1932, pp. 467–471; and Sept. 23, pp. 501–506. Review of the hydro-electric power resources of Italy and of the most important recent great projects, with special reference to a curved concrete gravity dam on the Orco River at Ceresole, having a height of 56 m; temperature observations on Ceresole Dam.

Power Canals. Note sul canale dell'impianto idroelettrico di Mori sull'Adige, L. Manfredini, *Energia Elettrica*, vol. 9, no. 10, Oct. 1932, pp. 882–888. Design and construction of power canals for Mori hydro-electric plant on Adige River, in Italy; canal, having a capacity of 195 cu m per sec, is 2,450 m long and has a slope of 0.24 m per km; design and construction of concrete lining, wasteways, and outlets, etc.; grouting with clay.

Tailrace Flow. Note sur l'onde positive de translation dans les canaux d'usines, J. Calame. *Bul. Technique de la Suisse Romande*, vol. 58, no. 14, 15, 16, and 17, July 9, 1932, pp. 167–169; July 23, pp. 174–180; Aug. 6, pp. 190–193; and Aug. 20, pp. 201–205. Theoretical mathematical analysis of flow and surface curves in tailrace canals of hydro-electric power plants under conditions of sudden changes in the régime of hydraulic turbines, covering cases of rectangular and other canal sections; effect of slope and friction factors; effect of surface curve fluctuations on surge tanks.

Tunnels. Big Bottom Power Tunnel Near Portland, C. Fuller. *West. Construction News and Highways Bldr.*, vol. 7, no. 22, Nov. 25, 1932, pp. 653 and 654. Driving of Big Bottom Tunnel for Oak Grove Project of Portland General Electric Company—4 miles long and 10 ft in diameter—bringing water from Main Clackamus River to augment the flow of Oak Grove Fork.

HYDROLOGY, METEOROLOGY, AND SEISMOGRAPHY

Anemometers. Methods of Recording Rapid Wind Changes, A. Magnan. *Nat. Advisory Committee for Aeronautics—Tech. Memo.*, no. 692, Nov. 1932, 13 pp., supp. plates. Operating principles and use of hot-wire anemometer for determining speed and direction of wind; measurement of turbulence.

Calibration. Standard Pitot-Static Tube Calibration at Low Air Speeds, E. Ower and F. C. Johansen. *Engineer*, vol. 154, no. 4010, Nov. 18, 1932, pp. 500–502. Extension of calibration of anemometers to as low a speed as possible; development of experimental procedure and apparatus; range of calibration and details of experiments; measurement of swirl.

Hydrology, Great Britain. Organization Required for Recording of Water Levels and River Flow in British Isles. *Water and Water Eng.*, vol. 34, no. 410, Nov. 21, 1932, pp. 543–550. Abstract of discussion at the York Meeting of the British Association.

Lakes, Utah. Fresh-Water Arm for Great Salt Lake, N. L. Wilson. *West. Construction News and Highways Bldr.*, vol. 7, no. 22, Nov. 25, 1932, p. 652. Outline of the project for diking off area of 146 sq mile of Great Salt Lake, for impounding water of Jordan River and surplus run-off of Weber River.

Meteorology. I monsoni dell 'Oceano Indiano al suolo e a quota, F. Eredia. *Rivista Marittima*, vol. 65, no. 9, Sept. 1932, pp. 185–210. Study of wind direction at low and high altitudes during different seasons over Indian Ocean.

IRRIGATION

Canals, Silt. Effect of Silt Conduction by Outlets on Régime of Channel, K. R. Sharma. *Indian Eng.*, vol. 92, no. 16 and 17, Oct. 15, 1932, pp. 315 and 316; and Oct. 22, pp. 335 and 336. Theoretical mathematical study of the part played by outlets in increasing or decreasing proportion of silt charge in supply of channel; effect of these changes in designing régime section for it; effect of outlets on grade of silt. (To be continued.)

Models. Note on "Model Experiments to Ascertain Effect of Raising and Widening Bed of Tribeni Canal Over Naraingarh Aqueduct," S. C. Nandi. *Indian Eng.*, vol. 92, no. 15, Oct. 8, 1932, pp. 292–295. Tests of model, made at Bihar College of Engineering, India, for study of flow and silting phenomena in large irrigation canal.

LAND RECLAMATION AND DRAINAGE

Zuiderzee. Reclamation of Zuiderzee, A. L. Shaw. *Eng. News-Rec.*, vol. 109, no. 22, Dec. 1, 1932, pp. 639–643. Construction of project described in many previously indexed articles; 20 miles of massive dikes built to shut off major part of the Zuiderzee from the North Sea; shafts of basalt used for paving slopes exposed to wave action; clay used for topping out dike; ship locks; pumping stations; in 1924 estimated cost of works was about $220,000,000.

MATERIALS TESTING

Dams, Testing. Spannungsmessungenin Staumauern, N. Kelen. *Gas- und Wasserfach*, vol. 75, no. 35, Aug. 27, 1932, pp. 698–700. Construction and method of use of telemeters and of Schaefer-Maihak acoustic apparatus, based on determination of a change in the tone of a musical string exposed to the effect of strain in masonry.

Steel, Temperature Effect. Properties of Steel as Affected by Increase of Temperature, W. H. Hatfield. *Manchester Ass'n Engrs.—Trans.*, 1931–1932, pp. 185–231 (discussion) 231–242, 4 supp. plates. Effects as regards two ranges of temperature; properties of steel up to, and including, 550 C; corrosion; heat-resisting steels; influence of industrial gases.

PORTS AND MARITIME STRUCTURES

France. Die franzoesischen Seehaefen, Lohmeyer and Bolle. *Bautechnik*, vol. 10, no. 40, Sept. 13, 1932, pp. 515–528. Review of passenger landing and cargo handling facilities of modern French ports, particularly Cherbourg, Le Havre, and Marseilles; features of new port structures at Le Havre, Le Verdon, St-Nazaire, and Bordeaux.

Quay Walls, Water Pressure. Beobachtungen ueber die Grundwasserbewegung hinter einer dichten Uferwand im Tidegebiet, Walther *Bautechnik*, vol. 10, no. 39, Sept. 9, 1932, pp. 495–497. Observations on ground-water movements back of impervious sheet piling and quay walls in tidal water of port of Norderney, Germany.

Wave Forces. Measurement of Waves and Wave Forces in Relation to Their Effect on Marine Structures, J. H. Cardew. *Australian Surveyor*, vol. 4, no. 2, June 1932, pp. 80–97. Theory of ocean and shallow water waves and their measurements; records of observation in various parts of the world; pressure and velocity diagrams; height, length, and period of observed ocean waves. Before Inst. Surveyors.

ROADS AND STREETS

Brick. Asphalt Overflow Removed by Luting Brick. *Eng. News-Rec.*, vol. 109, no. 22, Dec. 1, 1932, p. 651. Luting compound resembling paper-hangers' paste enables overflow of joint filler to be peeled cleanly from brick in paving work at Cleveland, Ohio.

Concrete. Raising 1,020 Ft of Pavement Without Causing a Crack. *Contract Rec.*, vol. 46, no. 47, Nov. 23, 1932, pp. 1309–1311. Raising of Toronto Street built over yielding fill, by means of grouting with cement and lime mixtures.

Construction. Slipping Road Fill Held Up by Steel Suspenders, T. H. Cutler. *Eng. News-Rec.*, vol. 109, no. 23, Dec. 8, 1932, pp. 684 and 685. System of steel plates suspended from top of fill holds slope of refilled slide of highway embankment at the Bagnell Dam, in Missouri; cone supports at top of slope prevent suspenders from sinking into fill.

Costs. Unit Bid Summary. *West. Construction News and Highways Bldr.*, vol. 7, no. 23, Dec. 10, 1932, pp. 696, 698, and 700. Unit costs bid on street and road work in Arizona, California, Montana, and Nevada.

Curves. Radii of Curbs at Intersections, Lefferts. *Pub. Works*, vol. 63, no. 12, Dec. 1932, p. 27. Principles of design from the point of view of the automobile driver and pedestrian. From a bulletin issued by the American Road Builders Ass'n.

Design. New Vertical Curves Table Shortens Computations, C. Walters. *West. Construction News and Highways Bldr.*, vol. 7, no. 23, Dec. 10, 1932, p. 682. Presentation of table requiring only one computation to obtain each correction from tangent grade.

Forests. Method for Determining Economic Value of Forest Road, J. P. Martin and T. W. Norcross. *Journal Forestry*, vol. 30, no. 8, Dec. 1932, pp. 988–1003. Outline for investigation of all pertinent factors affecting forest roads; transportation costs and speeds; saving in operation and travel time; administration, utilization, and protection; examples.

Great Britain. Road Developments in Great Britain. *Quarry and Roadmaking*, vol. 37, no. 432, Dec. 1932, pp. 533 and 534. Abstract of 1931 report on administration of road fund; classification and maintenance grants; road, bridge, and tunnel construction; mileage of public highways; experimental work.

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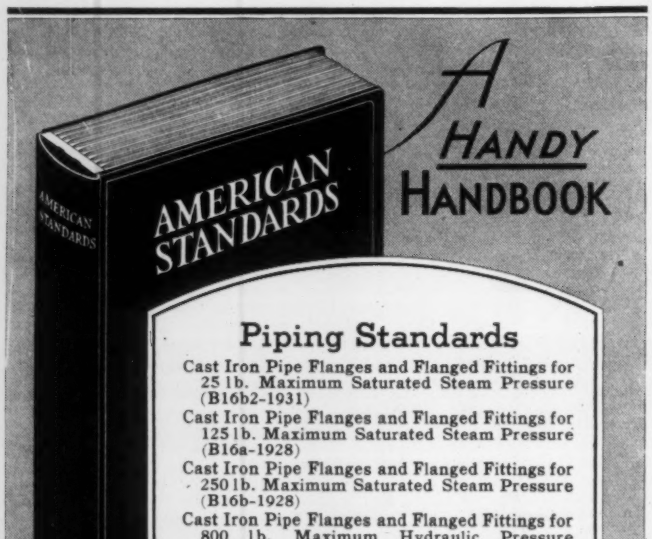

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Highway Systems, United States. Extra Wide Highways on State Systems. *Pub. Roads*, vol. 13, no. 9, Nov. 1932, pp. 148–191. Statistical study; mileage of extra wide surfaced roads on state highway systems, 1931, including only rural roads over two lanes wide, as reported by state authorities.

Impact. Road Impact Produced by Heavy Motor Bus, J. A. Buchanan. *Pub. Roads*, vol. 13, no. 9, Nov. 1932, pp. 137–147 and 151. Investigation by the Bureau of Public Roads, in cooperation with the Rubber Manufacturers' Association and the Society of Automotive Engineers for the determination of impact forces exerted on pavement by balloon tire wheels of motor trucks and buses; tests involving artificial obstructions; tests involving natural obstructions; magnitude of reaction vs. frequency.

Low-Cost. Bituminous Surface - Treatment Methods. *Pub. Works*, vol. 63, no. 10, Oct. 1932 pp. 16–18. Summary of data furnished by engineers of various companies manufacturing bituminous materials.

Maintenance and Repair. Notes on Maintenance of Salt-Clay Highways, A. R. Chambers. *Can. Engr.*, vol. 63, no. 23, Dec. 6, 1932, pp. 13–15. Experiments with salt in surface treatment of roads in Nova Scotia; method of application; salt and its effect on gravel and earth roads; dust absorbing properties of salt. Before Can. Good Roads Ass'n.

Materials, Fillers. Fillers for Asphalt, Pitch, and Tar, A. B. Searle. *Roads and Road Construction*, vol. 10, no. 119, Nov. 1, 1932, pp. 332 and 333. Essential properties of filler which is to be mixed with bitumen, pitch, or tar in order to produce artificial asphalt; size particles; penetrability; chemical inertness; suspendibility; strength; specific gravity; typical fillers: slate-dust, brick-dust, granite, asbestos, slags, limestone-dust, hydrated lime, portland cement, magnesia, gypsum, and waste plaster of paris, etc.

Nova Scotia. Snow Removal from Roads of Nova Scotia, R. W. McColough. *Contract Rec.*, vol. 46, no. 50, Dec. 14, 1932, pp. 1377 and 1378. Equipment, methods, and costs. Before Union Nova Scotia Municipalities.

Snow Removal, Michigan. Equipment for Snow Removal in Michigan, B. C. Tiney. *Pub. Works*, vol. 63, no. 12, Dec. 1932, pp. 30 and 32–33. Use of blade plows, truck V-plow, truck rotary plows, and trucks; drift control; snow fences; icy roads.

SEWERAGE AND SEWAGE DISPOSAL

Activated Sludge. Activated Sludge: New Process for Partial De-Watering and Subsequent Disposal, H. D. Bell. *Surveyor*, vol. 82, no. 2132, Dec. 2, 1932, pp. 507 and 508. Barnsley sludge disposal experiments; use of clays as coagulant; results from use of sands; other experiments; separation of at least two-thirds of original water content can be effected in 3 hr, by mixing sludge with materials whose particles present rough surface. Before Ass'n. of Managers of Sewage Disposal Works.

Design. Planning Sewage Systems for Public Health Requirements, J. C. Keith. *Can. Engr.*, vol. 63, no. 24, Dec. 13, 1932, pp. 21–23. Factors to be considered in the design and construction of sewage system; various treatment processes. Before Ontario Health Officers' Ass'n.

Equipment. Mechanical Equipment in Sewage Treatment Works—VII, A. P. Folwell. *Pub. Works*, vol. 63, no. 12, Dec. 1932, pp. 18–20. Oxidizing beds; percolating filters; contact beds; intermittent sand filters.

Germany. Die Entwicklung der Abwasser-Reinigungsverfahren und das Berliner Grossklaerwerk Stahnsdorf, F. Langbein and E. Weise. *Bautechnik*, vol. 10, no. 40, Sept. 13, 1932, pp. 529–544. Design and construction of recently completed Stannsdorf unit of Berlin sewage disposal system; outline of physical, chemical, and biological methods of sewage purification; capacity of plant is 190,000 cu m per day; details of sewage tanks, mechanical and electrical equipment, etc.; outline of gas-recovery process which is to yield ultimately 12,000 cu m of gas per day; details of concrete construction.

Pumping Plants, Germany. Die neuen Abwasserhebewerke der Stadt Breslau, K. Gewecke. *Bautechnik*, vol. 10, no. 36 and 38, Aug. 19, 1932, pp. 455–457; and Sept. 2, pp. 478–481. Structural features and equipment of three low-head sewage pumping plants at Breslau, Germany; use of centrifugal pumps and compressed air pumping equipment.

Sludge. Dewatering of Sludge by Vacuum Filtration, C. E. Keefer and E. C. Cromwell. *Sewage Works Journal*, vol. 4, no. 6, Nov. 1932, pp. 929–959. Baltimore Bureau of Sewers tests of experimental filters made by Bartlett-Hayward Company, and Oliver United Filters, Inc., using material from same digestion tanks; dewatering digested, semi-digested, and raw sludge; effect of heat on filtration; coagulation with chlorinated copperas, and with ferric chloride and lime; cost of filtration and air-drying of sludge; estimates of sludge filters.

— Sludge Digestion. *Surveyor*, vol. 82, no. 2133, Dec. 9, 1932, p. 541. Excerpts from the 1932 annual report of the City of Manchester Rivers Department; sludge digestion plant experiments; future sludge treatment; digestion of activated sludge; reduction in sludge volume; gas production.

Tokyo, Japan. Sewerage System of Tokyo, W. H. Clarke, Jr. *Far East Rev.*, vol. 28, no. 10, Oct. 1932, pp. 466–471. Excerpts from the report of the chief engineer, Z. Hara, of the Department of Public Works and chief of the Tokyo sewerage works bureau, describing a system designed to serve a population of 3,440.000.

STRUCTURAL ENGINEERING

Domes, Concrete Slabs. Precast Light-Weight Concrete Slabs Placed on Capitol Dome. *Concrete*, vol. 40, no. 12, Dec. 1932, p. 9. Reconstruction of the dome of the Illinois State Capitol; precast units weigh only 14 lb per sq ft; design, manufacture, and placing of slabs.

Girders, Continuous. Der Momentenausgleich in den Endfeldern von durchlaufenden Traegern, K. Hajnal-Konyi. *Stahlbau (Supp. to Bautechnik)*, vol. 5, no. 17, Aug. 19, 1932, p. 134. Theoretical discussion of the effect of plastic deformation on the distribution of stresses in panels of continuous girders: equalization of moments.

TRAFFIC CONTROL

Chicago. Chicago Regional Traffic Survey. *Highway Engr. and Contractor*, vol. 41, no. 4, Oct. 1932, pp. 17–19 and 21–26. Preliminary data in analysis for future development plan, made by the Committee on Traffic and Public Safety, state highway system; rural-urban traffic flow; traffic pressure; traffic origin; destination; facility of movement.

TUNNELS

Drainage Tunnels. Notes on Tunnel Driven at Stan Trg Mine, Yugoslavia, D. J. Rogers. *Inst. Min. and Met.—Bul.*, no. 339, Dec. 1932, 18 pp., supp. plates. Adit tunnel driven from Oct. 19, 1929 to May 12, 1931, for draining and exploiting ore bodies in one of the Trepca Mines, Ltd., Yugoslavia; general details; tunnel excavation; disposal of waste; cycle of operations; power and subsidiary equipment; statistical data and costs.

Railroad, Demolition. Old Tunnel Demolished with Trains Running. *Eng. News-Rec.*, vol. 109, no. 21, Nov. 24, 1932, pp. 620–622. Method of daylighting the oldest American railroad tunnel, 1,000 ft long, of the Delaware and Hudson Railroad, at Whitehall, N.Y.; pressed-steel liner plates form roof over trains while daylighting.

Vehicular, Oregon. Elk Creek Tunnel, Umpqua Highway, Oregon, R. A. Klein. *West. Construction News and Highways Bldr.*, vol. 7, no. 23, Dec. 10, 1932, pp. 679–682. Construction of concrete-lined vehicular tunnel, (1,090 ft long and 26 ft wide), crossing a hill in western Douglas County, Oregon.

Water Supply, British Columbia. Construction of Bridge River Tunnel, C. E. Blee. *Can. Engr.*, vol. 63, no. 24, Dec. 13, 1932, pp. 31–33. Method employed in lining tunnel with concrete; amounts of overbreak concrete; grouting. (Concluded.)

WATER PIPE LINES

Concrete. Berechnung von Schleuderbetonrohren fuer Kanaldueker, Durchlaesse usw, O. Stoltzenburg. *Bautechnik*, vol. 10, no. 31 and 33, July 15, 1932, pp. 405–408; and July 29, pp. 423–426. Mathematical theory of the design of centrifugal concrete pipes for use in canal siphons, reservoir outlets, etc.; analysis of stresses due to interior and exterior pressures, dead weight of pipes, etc.

Cross Connections. Cross Connections with Public Water Supplies, S. B. Morris. *Am. Water Works Ass'n—Journal*, vol. 24, no. 11, Nov. 1932, pp. 1750–1757 (discussion) 1757–1761. Fixtures inviting cross connections; actual examples of contamination from faulty fixtures and from faulty piping; examples of contamination through careless operation; tests of plumbing fixtures under partial vacuum; recommendations of U.S. Bureau of Standards; field tests of extent of vacuums in distribution systems; test of momentary vacuum in office building; Pasadena establishes plumbing fixture board.

WATER RESOURCES

Underground. Beitrag zur Bestimmung der Ergiebigkeit wasserfuehrender Schichten, H. Weber. *Gesundheits-Ingenieur*, vol. 55, no. 33, Aug. 13, 1932, pp. 391–395. Development of a graphical method for the determination of yield of water-bearing strata; numerical examples.

WATER TREATMENT

Aeration. Wellsburg, W.Va., Water Works Has Simple Plant Arrangement for Treatment of Well Waters, M. J. Davis. *Water Works Eng.*, vol. 85, no. 24, Nov. 30, 1932, pp. 1414–1415. Operation of aeration, filtration, softening, and pumping equipment of water works of Wellsburg, W.Va., deriving its supply from two Layne wells, 24 in. in diameter and 70 ft deep; installation shows saving.

Biological Control. Biological Control as Affecting Plant Operation, C. Wilson. *Am. Water Works Ass'n—Journal*, vol. 24, no. 11, Nov. 1932, pp. 1792–1797 (discussion) 1797–1799. Organic load; troubles with high sulfates; selective draft from impounding reservoirs; refinements in plant operation; effect on water-softening processes.

Filtration Plants, Design. Rapid Filter Hydraulics Disclosed by Experiments, R. Hulbert and D. Feben. *Eng. News-Rec.*, vol. 109, no. 22, Dec. 1, 1932, pp. 647–650. Report on experimental study, by the Detroit Department of Water Supply, of factors determining the length of filter run in water-purification plants; formula derived which enables designing engineer to compute accurately that part of the initial loss of head due to the sand bed itself; loss of head for 16 graded test sands.

Germany. Wasserversorgung im mittleren Ruhrkohlenbezirk mit besonderer Beruecksichtigung der Stadt Essen, B. Nerreter. *Gas- und Wasserfach*, vol. 75, no. 33, Aug. 13, 1932, pp. 653–660. Description of water works and waterworks practice of the central section of the Ruhr Coal Basin, with special reference to the water works of the city of Essen; chemical analysis of waters from Ruhr and Rhine rivers.

Manganese Removal. Iron and Lime in Removal of Manganese, E. C. Craig, E. L. Bean and R. W. Sawyer. *Am. Water Works Ass'n—Journal*, vol. 24, no. 11, Nov. 1932, pp. 1762–1776 (discussion) 1776–1779. Experience of the city of Providence, R.I., with red water; manganese troubles; copperas-lime treatment; coagulation; filtration; cleaning filters; handling of chemicals; experimental work.

Taste and Odor Removal. Report of Committee on Control of Tastes and Odors. *Am. Water Works Ass'n—Journal*, vol. 24, no. 11, Nov. 1932, pp. 1738–1748 (discussion) 1748 and 1749. First report of the special committee of the American Water Works Association; aeration; copper sulfate; ammonia-chlorine treatment; pre-chlorination; activated carbon; methods of determination; determination of phenol in water; recommendations.

Water Treatment Plants, Operation. Tuning Up Saginaw Water Plant. *Eng. News-Rec.*, vol. 109, no. 23, Dec. 8, 1932, pp. 686–687. Plant, put into operation 3 years ago and heralded then as the last work in flexibility, shut down during the passage of heavy salt wastes down the river; activated carbon controls tastes and odors; red water overcome by secondary dose of soda ash; operation data for Saginaw water works for 1930 and 1931; chemical costs.

WATER WORKS ENGINEERING

Alabama. Filtration Plant Capacity Doubled, J. E. Jagger. *Am. City*, vol. 47, no. 6, Dec. 1932, pp. 49–52. Description of the new water works of Wetumpka, Ala., owned by the Alabama Water Service Company, serving a population of 2,400; description also of one of the units of the Alabama Mills Company.

Distribution Systems, Los Angeles, Calif. Expansion of Los Angeles Distribution System, W. W. Hurlbut. *Am. Water Works Ass'n—Journal*, vol. 24, no. 11, Nov. 1932, pp. 1684–1696 (discussion) 1696–1699. History of Los Angeles water works since 1902; statistical data; Los Angeles aqueduct supply; replenishing underground gravels; distribution system and reservoirs; local area distribution; growth of system.

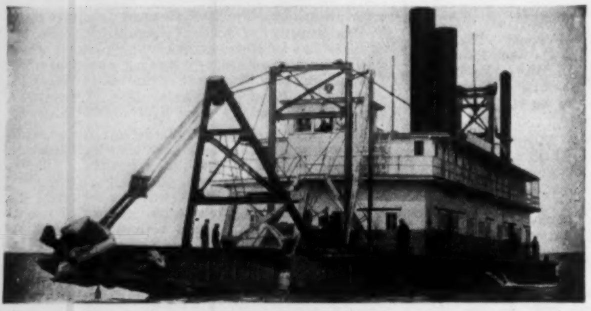
Germany. Die Wasserversorgung des Industriegebietes von Norden, Schmick. *Gas- und Wasserfach*, vol. 75, no. 32, Aug. 6, 1932, pp. 637–641. Review of water-works practice and of recent developments in the Industrial District of North-Westphalia coal basin; statistical data; features of water wells, roller weirs, etc.

Great Britain. Wolverhampton Corporation Water Supply. *Water and Water Eng.*, vol. 34, no. 410, Nov. 21, 1932, pp. 529–537. Description of new water works of 3 mgd capacity, which cost £82,400 and comprise water wells, pumping plant, and pipe line.

Greece. Athens Nye Vandvaerksanlaeg, A. B. Christensen. *Ingenioeren*, vol. 41, no. 44, Oct. 29, 1932, pp. 505–510. Layout and construction of the new water-supply system of Athens with particular regard to the Marathon Dam and Boyati Tunnel; capacity of reservoir 40,000,000 cu m; length of tunnel 13.4 km.

Operation. Der selbsttaetige und ferngesteuerte Betrieb von Wasserwerken, Dittmer. *Gas- und Wasserfach*, vol. 75, no. 46, Nov. 12, 1932, pp. 901–904. Review of modern practice of automatic and remote control operation of water works, with special reference to German experience.

Waste Control. Underground Waste Detection as a Factor in New York Water Conservation Program, F. B. Nelson. *Am. Water Works Ass'n—Journal*, vol. 24, no. 11, Nov. 1932, pp. 1709–1714 (discussion) 1714–1716. Results of preliminary survey illustrating water saving that may be accomplished in a short time by simple direct methods; computing amount of leakage



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